Issued October 9, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—BULLETIN 99.
HENRY S. GRAVES, Forester.

USES OF COMMERCIAL WOODS OF THE UNITED STATES:

II. PINES.

FOREST SERVICE
OCT 26 1911
RECEIVED
Answered

BY

WILLIAM L. HALL,
ASSISTANT FORESTER,
AND
HU MAXWELL,
EXPERT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

Issued October 9, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—BULLETIN 99.
HENRY S. GRAVES, Forester.

USES OF COMMERCIAL WOODS OF THE UNITED STATES:

II. PINES.

BY

WILLIAM L. HALL,
ASSISTANT FORESTER,
AND
HU MAXWELL,
EXPERT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Forest Service,
Washington, D. C., June 10, 1911.

Sir: I have the honor to transmit herewith a manuscript entitled, "Uses of Commercial Woods of the United States: II. Pines," by William L. Hall, Assistant Forester, and Hu Maxwell, Expert, and to recommend its publication as Bulletin 99 of the Forest Service.

Respectfully,

Henry S. Graves,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
Longleaf pine	8
Physical properties	8
Supply	8
Early uses	9
Exports	10
Shipbuilding	11
Heavy construction	11
Railroad timbers	12
Manufacture and products	12
Paving blocks	13
Miscellaneous	14
Naval stores	14
By-products	16
Shortleaf pine	17
Physical properties	17
Supply	17
Early uses	18
Manufacture and products	19
Loblolly pine	20
Physical properties	20
Supply	20
Early uses	22
Manufacture and products	22
Railroad timbers	23
Fuel	24
Cuban pine	24
Physical properties	24
Supply	24
Manufacture and products	25
Pond pine	26
Physical properties	26
Supply	26
Manufacture and products	27
By-products	27
Spruce pine	27
Physical properties	27
Supply and uses	28
Sand pine	28
Physical properties	28
Supply and uses	29

Page.
Scrub pine 29
Physical properties 29
Supply 29
Uses 30
Table Mountain pine 31
Physical properties 31
Supply and uses 31
Pitch pine 31
Physical properties 31
Supply 32
Early uses 32
Farm timber and boat building 34
Manufacturing 34
White pine 35
Physical properties 35
Supply 35
Early development 37
White pine lumbering 39
Shipbuilding 43
Bridges 44
Houses 45
Shingles 46
Furniture 47
Boxes 48
Cooperage 48
Farm uses 49
Water pipes 50
Miscellaneous uses 51
By-products 53
Diseases 53
Norway pine 54
Physical properties 54
Supply 54
Shipbuilding 55
By-products 56
Jack pine 57
Physical properties 57
Supply and uses 57
Western white pine 58
Physical properties 58
Supply 58
Uses 59
Western yellow pine 61
Physical properties 61
Supply 61
Early uses 63
Manufacture and products 63
Sugar pine 65
Physical properties 65
Supply 65
Early uses 66
Manufacture and products 67

Page.
Lodgepole pine 69
Physical properties 69
Supply 69
Wigwam poles 71
Early uses 71
Mine timbers and fence posts 72
Manufacture and products 72
Jeffrey pine 73
Physical properties 73
Supply 74
Uses 74
Arizona longleaf pine 75
Chihuahua pine 75
Physical properties 75
Apache pine 75
Arizona pine 76
Physical properties 76
Supply and uses 76
Mexican white pine 76
Physical properties 76
Supply and uses 76
Singleleaf piñon 77
Physical properties 77
Supply 77
Local uses 78
By-products 79
Mexican piñon 81
Piñon 81
Physical properties 81
Supply and uses 82
Parry piñon 83
Physical properties 83
Supply and uses 83
Monterey pine 83
Physical properties 83
Supply and uses 83
Coulter pine 84
Physical properties 84
Supply and uses 84
Torrey pine 85
Physical properties 85
Supply and uses 85
Gray pine 85
Physical properties 85
Supply 85
Early uses 86
Manufacture and products 87
By-products 88
Whitebark pine 88
Physical properties 88
Supply and uses 89
Limber pine 91
Physical properties 91
Supply 91
Uses 92

Page.
California swamp pine 93
Physical properties 93
Supply and uses 93
Knobcone pine 93
Physical properties 93
Supply and uses 94
Bristlecone pine 94
Physical properties 94
Supply and uses 95
Foxtail pine 96
Physical properties 96
Supply and uses 96

USES OF COMMERCIAL WOODS OF THE UNITED STATES.

II. PINES.

INTRODUCTION.

Thirty-seven species of pine grow in the United States, no one species in all the States, yet, with perhaps one exception, no State is without one or more. Some, as the loblolly pine of the South, the white pine of the North and East, and the western yellow pine, occupy large regions in considerable abundance, while others, as the Apache pine of the Chiricahua Mountains of Arizona, the Torrey pine along the Soledad River in California, and the sand pine near the Gulf coast of Florida and Mississippi, are so scarce that few persons ever see and recognize them. Yet no species of pine is so scarce that it is not made in some way to serve man's needs.

About 48 per cent of the total lumber output for the United States in 1908 was pine. The longleaf probably furnished more than any other single species, and white pine was next. The western yellow pine, which is more widely distributed than any other pine of this country, is a large producer of lumber, and the western white pine and the loblolly also rank high in quantity. This bulletin considers each species separately. The places which some species occupy are very humble, and they can never rise much in the scale of usefulness, yet each one is entitled to its own individuality.

Four important timber trees of the southeastern United States are usually grouped as one in the lumber market, and are sold under the common name of yellow pine. They are the longleaf pine, shortleaf pine, loblolly pine, and Cuban pine. In appearance the woods of these four trees are so nearly alike that it is sometimes difficult to distinguish one from the other; yet in some particulars there is considerable difference. This is often seen in the growth rings. Longleaf annual rings are usually narrow, shortleaf wide near the heart, followed by a zone of narrower rings, while loblolly's rings are generally very wide. The Cuban pine also has wide rings. The proportion of sapwood to heart is usually different in the four species. Longleaf pine over a foot in diameter, breast high, rarely has sapwood over 2 or 3 inches broad; shortleaf sapwood in trees of like size usually measures 4 inches, while loblolly often runs from

4 to 6 inches. The sapwood of the Cuban pine resembles that of loblolly more than longleaf. In resin contents, longleaf is very abundant, loblolly less so, and shortleaf still less. In this particular Cuban pine ranks close to longleaf. The weight of the wood of the four species varies through rather wide limits, and it would perhaps not be practicable to distinguish them by that test alone.

LONGLEAF PINE (Pinus palustris).

PHYSICAL PROPERTIES.

Weight of dry wood.—43.6 pounds per cubic foot (Sargent).

Specific gravity.—0.70 (Sargent).

Ash.—0.25 per cent dry weight of wood (Sargent).

Fuel value.—94 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—16,100 pounds per square inch (Sargent).

Factor of stiffness (modulus of elasticity).—2,118,000 pounds per square inch (Sargent).

Character and qualities.—Heavy, hard, very strong; tough; grain fine, even, straight; compact, annual rings narrow, especially in young and old growth, summerwood broad, occupying fully half the width of the annual growth, proportion of heartwood large; very resinous, resin passages numerous and large; medullary rays numerous, conspicuous; color light red or brown, the thin sapwood light yellow; durable in contact with the soil.

Growth.—Height, 55 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of longleaf pine lies in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. Few woods have a greater number of names in different localities than this tree. Among them are longleaved pine, southern pine, yellow pine, turpentine pine, rosemary pine, brown pine, hard pine, Georgia pine, fat pine, southern yellow pine, southern hard pine, southern heart pine, southern pitch pine, heart pine, pitch pine, longleaved pitch pine, long-straw pine, North Carolina pitch pine, Georgia yellow pine, Georgia heart pine, Florida yellow pine, Florida pine, Florida longleaved pine, Texas yellow pine, Texas longleaved pine.

The total stand of the timber pines of the South is estimated by the Bureau of Corporations at 384 billion feet.[1] Of this amount, 232 billion feet is of longleaf and 152 billion feet of shortleaf and loblolly pine. The figures for the longleaf include whatever there is of Cuban pine, as the two species were not distinguished by the Bureau of Corporations. It has been roughly calculated that, at the present rate of cutting, the supply of the southern pines will last from 20 to 30 years; and since the rate of lumbering is relatively about the same for all regions where the different species grow, it is assumed that

[1] Report of the Commissioner of Corporations on The Lumber Industry, February, 1911.

failure of supply will come to the four species at about the same time. Much more of longleaf and loblolly remain than of shortleaf and Cuban.

Longleaf pine in many sections of the South reproduces itself with vigor, but because of its slow growth while young it fails to establish itself as well as the white pine of New England and the yellow pine of the far West. Fire is the one great enemy over all of its range, and destroys seedlings in vast numbers, though larger trees resist well where they have not been boxed for turpentine. The prospect that new growth will take the place of the forests now going down before the lumbermen is not encouraging, more because of slow growth than of difficulties in reproduction. The annual drain upon southern pine forests to supply the demand for lumber, and the fact that fires interfere so greatly with reproduction, must lessen the remaining supply very rapidly.

EARLY USES.

The early explorers and colonists encountered the longleaf pine practically all the way from the Chesapeake Bay to Texas, with the exception of southern Florida. As the country began to be settled immediate demand upon the forests was made for building material needed in an agricultural region. A hundred years ago it was claimed that 75 per cent of the lumber in residences in the longleaf-pine region was of this wood. In many cases the entire house, so far as it was made of wood, was of this material. The most frequent exception was the roof, where cypress was commonly employed, with occasional roofs of red cedar and southern white cedar. In some cases shingles of pine supplied roof material also. Barns, sheds, stables, and all farm buildings drew enormous supplies from the neighboring longleaf-pine forests, and the inclosing of fields and plantations added to the demand. Pickets for garden and yard fences were sawed from the wood, and post and plank fences were sometimes constructed wholly of it. When pine posts were used it was customary to select the dead timber that had become "fat," a term applied to wood surcharged with resin. It was claimed that sometimes timber left standing after it was dead would double in weight, merely from the accumulation of resin in it; but figures showing an increase in weight so large as that should be accepted with caution. It is certain, however, that the fat pine posts gave long service, which led to extensive use of that class of timber. Rail fences were common in early plantation days in the South, and the longleaf pine was split for rails and lasted well.

One of the earliest demands upon the longleaf pine was for bridge material. Public highways and private roads depended largely, some-

times almost wholly, upon it when streams and ravines were to be crossed.

Long-leaf pine contributed to the machinery used on southern plantations, though in early times the use of farm machinery was more limited than at present. A large part of the work was done by hand labor; but wagons and carts were indispensable, and the beds were oftener made of pine than of any other wood.

The old Ramage printing press, made a century and a half ago and now in the National Museum at Washington, D. C., is largely of longleaf pine.

EXPORTS.

The exportation of building material from the longleaf-pine region began very early, and the lumber for that purpose was sent in small sailing vessels to Cuba and the eastern coast of Mexico and Central America. It was preferred in many cases to the native timber, because it was comparatively free from attack by ants, which in tropical countries frequently destroy houses and eat away bridge timbers.

The southern pines attained to considerable importance in the export trade soon after the Revolution, and at the beginning of the Civil War were going in quantity to English markets. The closing of the southern ports early in the war left some of the operators and contractors with timbers on hand which they had expected to send abroad. A large number of rafts were caught in the Altamaha River by the blockade, and these the owners towed to places of concealment in estuaries and bayous, where they remained unmolested until the war's close.

It was about that time that the longleaf pine began to displace in English shipyards the pine from Memel (a port on the Baltic Sea).[1] It found place in heavy construction on land, as well as in shipbuilding. It was stronger than the Memel pine and could be had in longer pieces, up to 45, 50, and even 60 feet in length, and 14 inches square, free from sap. A favorite use for such timbers in England was for wharves and harbor works, as well as for supports for roofs and galleries in churches and other large buildings. Pavement was made of it for shop floors, each block being made of four pieces fastened together with dowels. The timber in England has given 20 years' service in damp and unfavorable places, but has not proved so satisfactory in South Africa, particularly near the Cape of Good Hope and near rivers, where the climate is alternately dry and damp.

In the export of lumber at the present time from the United States to foreign countries the southern yellow pines are not listed sepa-

[1] Timber, J. R. Baterden, London, 1908.

rately, and it is not practicable to determine what part of the total lumber exports they supply. It is believed, however, that a billion and a half feet of these pines go yearly to foreign countries, the most of it longleaf. This places it above Douglas fir, its next nearest competitor, as an export wood. The pine is sent in large quantities to Mexico, the West Indies, Central America, the Panama Canal Zone, South America, and to Great Britain and the Continent of Europe, as well as to many other parts of the world.

SHIPBUILDING.

From the earliest times the southern shipyards drew supplies from longleaf-pine forests. The timber was sent to northern yards also, and its value for masts was quickly recognized after the southern forests became known. It is heavier than white pine, and to some extent its weight was objectionable, but its other qualities were so much in its favor that it speedily won its way. Before supplies began to be drawn from the South the Riga and Danzig pines from northern Europe furnished masts for a majority of European vessels, but in a few decades after commerce with the South began the longleaf pine had distanced its competitors in that trade. For the largest masts, however, it could not compete with the New England white pine. Spars, yards, and other timbers employed in ship rigging were bountifully supplied by longleaf pine, and large quantities of sawed planks were used.

The first war vessels built by the United States Government, beginning about 1797, used longleaf pine to some extent, though the frames and other parts subjected to shock and strain were of live oak. The six vessels forming the first Federal Navy had the southern pine in them. The *Constitution*, launched at Boston in 1797, and which in its long and eventful history captured 16 ships, still rides at anchor at Boston, but it can scarcely be called the same vessel that won the victories nearly a century ago, for piece by piece it has been rebuilt until practically all the old wood has been replaced by new. However, the figurehead that ornamented the prow of the ship when it first sailed remains, though it shows the weathering effect of over 100 years of sunshine and storm. It is of longleaf pine—a wood which in this instance has outlasted all that were associated with it in the building of the ship.

Boat builders in all eastern and southern yards of the United States use longleaf pine. It serves in nearly every part of boat frames and planking, in large craft as well as in small.

HEAVY CONSTRUCTION.

Only one other timber in the United States at present stands on an equal footing with longleaf pine in heavy construction, such as

beams, girders, sills, sleepers, joists, trusses, rafters, columns, and heavy floors, and planking. That wood is Douglas fir of the Pacific coast. It has been said that lumber dealers do not always distinguish between longleaf, shortleaf, loblolly, and Cuban pines, but longleaf is the most important of the group. Its strength, stiffness, freedom from defects, and its lasting properties fit it for many places in heavy construction. The demand for pieces of unusual size is met to a large extent by southern mills which cut this species.

RAILROAD TIMBERS.

In 1907 the railroads of the United States purchased 34,215,000 ties of southern pine. In 1908, largely due to the financial depression, the number fell off to 21,530,000, and decreased to 21,385,000 in 1909. It is impossible to tell what proportion was of longleaf, but it is known that it was large. The cutting of ties in the southern pine forests has caused much waste. It has been estimated that not less than 70 feet of lumber are sacrificed to procure one tie, which, at most, contains not above 50 feet, and generally nearer 40. Ties are usually cut from young trees.

Builders of railroad bridges and trestles draw a large part of their heavy timbers from the longleaf forests. The wood is preeminently fitted for that use. It may be had in long pieces, free from serious defects, and possesses great strength and stiffness. In addition to that, it has enduring qualities which add much to its value.

It is extensively employed in car building, to some extent for passenger cars, but chiefly for freight. It is used for siding, lining, roofing, flooring, beams, and frames. The timber's elasticity is its chief value in car building. Sticks free from defects are often demanded 10 inches square and from 36 to 42 feet lo[illegible] Elasticity adds value to the crosstie also, for the wood must yield under weight and strain and quickly recover its former shape and position.

MANUFACTURE AND PRODUCTS.

Southern pine has always had a place as interior finish in the South, but until comparatively recent years it was not favored for fine work, but was chiefly confined to kitchens, pantries, back stairways, and similar places. It was nearly always finished in natural colors, if finished at all; but when it was discovered that it took stains well it quickly rose to importance and has attained wide use. In the best construction, however, it has never reached a footing equal to oak, chestnut, and birch. Immense quantities are made into flooring, and manufacturers of window and door frames and of sash and doors draw supplies of raw material liberally from that source. It finds place as finish for kitchens, halls, libraries, and

sleeping apartments. It is made into stairs, railing, molding, spindles, balusters, and newel posts. Church and schoolhouse finish is made of it, and it has extensive use in the manufacture of furniture, cabinets, and wardrobes. Various parts of machines are made of it in southern mills, shops, and factories, and the makers of farm machinery and appliances use it in many ways where formerly ash and oak were the only woods employed. In a large part of the country it is so universally used that there are but few places of importance that it does not fill.

Formerly it was customary for large contractors to specify that the timbers supplied should not be "bled," referring to the practice of extracting crude turpentine from living trees. It was supposed that the wood from such timber was inferior. Railroad companies frequently excluded such stock. Tests by the Forest Service some years ago showed that "bled" timber is not reduced in strength. The bleeding does greatly increase the amount of resin in the butt of the tree, and this is sometimes found objectionable. Also, the turpentining of the tree does reduce to some extent the quantity of first-class lumber which can be obtained.

PAVING BLOCKS.

The extensive use of wooden paving blocks, treated with preservatives to retard decay, covers a period of only a few years in this country, and longleaf pine has been the principal wood so used. Before the necessity for wood preservation and the methods of bringing it about were well understood, a large amount of wood pavement was laid in many cities of this country. Of this untreated wood pavement there was probably more northern white cedar from the Lake States than of all other woods combined. The unsatisfactory use which such pavement gave led to its abandonment, and treated woods came in. The hard southern pines, particularly the longleaf pine, were favored by many cities, and in 1909 more than a million square yards of this timber received treatment for use as paving blocks. Some use of it was made long before. Between 1860 and 1870 Brooklyn laid pavement of this wood previously dipped in coal tar. The average life of the blocks under traffic in that city was about 6 years.

Treated paving blocks of the southern pines have replaced other materials to a considerable extent in many American cities and have gained some foothold in European cities. In this country they have been laid in New York, Boston, Baltimore, Washington, Indianapolis, Chicago, Minneapolis, Duluth, and in other cities. In addition, much wooden pavement has been laid between car tracks in cities, on wharves and landings, in coal yards, on bridges, in ware-

houses, foundries, shops, roundhouses, breweries, cellars, bottling works, and in many situations where heavy wear must be sustained and liability to decay resisted.

MISCELLANEOUS.

Longleaf pine is largely employed in railroad water tanks, towers, for windmills, and receptacles for liquids in factories and mills. The tank itself and the stand on which it is placed are frequently of this wood, but in tank building longleaf pine is not as extensively used as cypress.

Trunk makers use many woods in their business, and longleaf pine has a prominent place, though its weight places it at a disadvantage when competing with others.

Excelsior cutters draw upon it for supplies, but it has no superiority for that use over many other woods.

A small quantity of longleaf pine is manufactured into pulp, the material used for the most part being sawmill waste. At certain plants in the South it appears that the process of making paper from sawmill waste is becoming established on a successful basis. If so, it means the extension of the pulp industry to the Southern States, with longleaf pine as the raw material.

The long, clear timbers cut from this pine are well adapted to the manufacture of wooden pumps, and a considerable amount is so used.

Elevator builders draw supplies from the longleaf lumber yards of the South, where clear stock and exceptional lengths may be had.

NAVAL STORES.

Longleaf pine has held an important place in the production of naval stores since the development of the country began. A century ago Michaux listed the longleaf pine's products as "wood turpentine, scrapings, spirits of turpentine, rosin, tar, and pitch." He described turpentine as the raw resin that exuded from the wounds in the trees; scrapings, as the dried substance that adhered to the wounded surface; spirits of turpentine, as the product passing over in distillation of turpentine; rosin, the residuum of distillation; tar, the substance obtained by the destructive distillation of pine wood; and pitch, the product obtained by boiling the tar. Longleaf pine has been and still is nearly the entire source of these products.

Immediately after settlements began on the Atlantic coast Great Britain encouraged the development of the naval-stores industry. Her ships demanded large quantities, and the supply then came from the Baltic Provinces and from Russia. Monopoly, it was claimed, raised the price, and in time of war there was danger that supplies

would be cut off. For that reason it was desirable that America should become a producer of the commodities so necessary to the maintenance of England's position upon the seas. The colonists in New England had scarcely landed before they were encouraged to look into the possibility of developing the naval-stores industry. The same was true in Virginia. Within 15 years after the feeble settlement had planted itself at Jamestown a report was made on the possibilities of developing the tar and pitch industries in the region on and near the coast of Virginia.[1] The report was unfavorable, for the reason, as it was set forth, that pines were too much dispersed to make the manufacture of pitch and tar profitable. This report has been construed as evidence that pine was much scarcer in the original forests of tidewater Virginia than in the secondary forests which grew afterwards.[2] The prevailing pine in that region is loblolly, which readily takes possession of abandoned fields.

The manufacture of naval stores began on a small scale in the longleaf pine region and grew gradually. Statistics showing the progress of the industry are fragmentary. In 1704 the shipments of tar to England from the Carolinas amounted to 400 barrels. One hundred years later the annual output of the South was 77,827 barrels. How much of this was tar and how much was rosin and other products is not shown. The shipments went to Northern States and to Europe. In the North the article was employed to a considerable extent by soap manufacturers. In the same year (1804) 19,526 gallons of spirits of turpentine were shipped from North Carolina. In later years petroleum was substituted for spirits of turpentine in many arts and industries.

The value of the naval stores produced in the United States in 1908, chiefly from longleaf pine, was $21,895,950. Florida was the largest producer. At one time North Carolina stood first, then the first place went to Georgia, and later to Florida. The center of the industry shifted from region to region where pine was most convenient and abundant. In early years the turpentine operators destroyed forests for naval stores alone and made no use of the wood. They boxed the trees—that is, cut deep notches in the base of the trunk—and collected resin year by year for a time. When the trees could produce no longer they were abandoned to fire and storms. The

[1] Neill's Virginia Co. of London, p. 283, report made in 1622.

[2] An inference that pine was plentiful near the sea, but not in the interior, has been drawn from a paragraph in John Oldmaxon's British Empire in America, edited by Hermann Moll, London, 1708. In accounting for the failure of grape culture in Virginia, he said: "Fir and pine trees, with which the country abounds, are noxious to the vine; and the experiments that have been made were in the lowlands, subject to the pine, and near the malignant influence of the salt water." (Vol. 1, p. 306.) Two hundred years ago, and about the same time that Oldmaxon wrote, John Lawson traversed the uplands of North Carolina for a distance of 125 miles and noted particularly that he saw no pine trees, but when he had proceeded eastward into what he called the "lowestmost parts" he encountered an abundance of pine.

weakened trunks were broken and fire completed the ruin. At the present time less wasteful methods are employed. The lumber is valuable and less frequently left to burn or decay. Improved methods have been found for extracting the resin. Cups are taking the place of the deep boxing that once was everywhere in use. Under the new system of working the product is better and more abundant, and the trees sustain less injury. In 1908 about 14 per cent of the turpentine was produced by the cup method. The improved processes continue to grow at a rapid rate.

A considerable portion of the longleaf pine forests of northern Alabama were denuded years ago to supply charcoal for iron furnaces in that region. A similar use of the wood has been made wherever sufficient market has existed for charcoal. In some localities refuse wood only is taken, while the rest goes to the lumber operators.

BY-PRODUCTS.

Several billion feet of yellow pine pass through dry kilns yearly, and it has been estimated that for every 1,000 feet entering the kiln a gallon of turpentine evaporates and is wasted, or an equivalent of 3 or 4 million gallons annually. It is believed that the expulsion of nearly all the turpentine from the wood is practicable, and that little or none of it need be wasted, while the quality of the lumber would be improved. Turpentine and pine oil are now being obtained from longleaf pine mill waste at a number of southern mills by steam distillation. At certain mills the shredded material is afterwards used for manufacturing paper. It is estimated that the waste of longleaf pine is sufficient to supply a quantity of turpentine equal to that now produced in the naval-stores industry. A large number of plants are running on longleaf pine stumps and "fat" logs by the destructive distillation process. The chief products of this process are turpentine, pine oil, pyroligneous acid, charcoal, and tar. In certain extraction processes the turpentine, pine oil, and rosin are obtained. The obtaining of such products from longleaf mill waste appears to be on the threshold of rapid increase.

The long needles of this pine have been used for various purposes. If distilled green, an oil of balsamic odor is obtained, closely resembling spirits of turpentine. By the distillation of the wood spirits of turpentine may be obtained, the yield running from 1 to 10 gallons per cord. Pine wool is made from pine needles by boiling them in a strong solution of alkali. The resulting fiber is cleaned, carded, and made into fabrics or used in upholstering.

One of the materials used in manufacturing lilac perfume is terpineol—made from turpentine. The manufacturers of synthetic camphor employ turpentine in the process. Pine oil has its largest use

at present among the varnish manufacturers, but there is a possibility of its use as a substitute for linseed oil in the manufacture of paints.

SHORTLEAF PINE (Pinus echinata).

PHYSICAL PROPERTIES.

Weight of dry wood.—38 pounds per cubic foot (Sargent).

Specific gravity.—0.61 (Sargent).

Ash.—0.29 per cent of dry weight of wood (Sargent).

Fuel value.—82 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,948,000 pounds per square inch, or 97 per cent that of longleaf pine (Sargent).

Character and qualities.—Heavy, hard, moderately strong; grain rather fine, even; annual rings generally wide near the heart, followed by zone of narrow rings; summerwood broad, often occupying half the width of the annual growth; resin moderately abundant, especially near base and near knots; resin passages numerous, medullary rays numerous, conspicuous; color, orange or lighter yellow, the sapwood nearly white; not durable.

Growth.—Height, 60 to 90 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of shortleaf pine lies principally in Alabama, Arkansas, Georgia, Louisiana, Missouri, North Carolina, South Carolina, and Texas. The lumber is known under many names in different localities, among them being yellow pine, spruce pine, bull pine, shortschat pine, pitch pine, poor pine, shortleaved yellow pine, rosemary pine, Virginia yellow pine, North Carolina yellow pine, North Carolina pine, Carolina pine, slash pine, and oldfield pine.

The botanical range of shortleaf pine is much more extensive than its commercial range. In many regions the growth is scattered, and only a few trees are found here and there. Early botanists reported the species as far north as Albany, N. Y., but it long ago disappeared from that latitude, and it is doubtful if it is now to be found north of central Pennsylvania. A century or more ago lumbermen cut large quantities of shortleaf pine on the main stream and tributaries of the Potomac and floated the logs to tidewater at Georgetown. The operations were west of the Blue Ridge, in contiguous parts of Maryland, Virginia, and Pennsylvania. Shortleaf pine has now ceased to exist as a source of lumber in that region.[1]

Thirty years ago the stand west of the Mississippi was estimated approximately at 95 billion feet. That was before much lumbering had been done in that part of its range. The largest cut of short-

[1] It is noteworthy that Indians who roamed through the Shenandoah Valley before its settlement by white people called the Shenandoah "Pine River," or, as the name was literally translated by Heckwelder, "River that flows past 'spruce pine.'" (William E. Connelley's Memoirs of John Heckwelder.)

leaf pine now comes from west of the Mississippi, in Texas, Arkansas, Louisiana, and Missouri. Estimates of the stand east of the Mississippi River would be hard to make, because the trees are scattered over 200,000 square miles, with dense timber growth scarcely anywhere.

The Commissioner of Corporations, in his report on the lumber industry in 1911, estimated the yellow-pine supply of the South to be 384 billion feet, of which 232 billion feet are of longleaf and 152 billion feet of shortleaf and loblolly combined.

It is the opinion of those who have studied the shortleaf pine's habit of growth and the extent of its natural range that it promises to continue one of the important timber trees of the South. If it fulfills that promise, however, it will be when better care has been taken of it than has been shown in the past. It has been exploited and abandoned to periodic forest fires, and the result is seen in a thin stand and a gradually contracting range. It possesses one advantage over nearly all other pines—the power to send up sprouts from stumps. The shortleaf pine's ability to send up sprouts is more pronounced west of the Mississippi than farther east.

EARLY USES.

The custom which has prevailed since early times of sending several species of pine to market under one name or many names renders it impossible to determine exactly to what extent shortleaf was used during the colonial period and later. It is known, however, that shortleaf was an important commodity more than 100 years ago. In fact, there is contemporaneous record that extensive cutting had depleted the supply a century ago along the Atlantic seaboard. It had gone to foreign countries, particularly to the West Indies, and at home it was a standard stock in shipyards at Baltimore, Philadelphia, New York, and Norfolk. It was used for masts, spars, yards, beams, planking, and interior lining, and for cabins and decks. The wood from New Jersey, Delaware, and the Eastern Shore of Maryland was generally considered finer grained and more compact than that grown farther south and back from the coast. Little or none is now cut in the coastal regions which once supplied the wood so highly esteemed for its excellent qualities.

Residences and farm buildings within the range of shortleaf pine and outside that of longleaf pine were largely built of it. It was seldom, however, the only wood used for that purpose. It was generally the floor material, the frames for doors and windows, and frequently the siding and ceiling. Where cypress or white cedar could be had for shingles, one or the other was usually employed, but in regions remote from the coast neither could be had, and in that case shingles were made from shortleaf pine, which often formed nine-tenths of the wood in a building. Farm fences and the pickets

that inclosed gardens and truck patches were of this pine in many instances. The heartwood was enduring, but the sap was disposed to decay quickly in damp situations.

Shortleaf pine was cut for fuel by the early residents throughout its range. It is rich in resin and burns brightly.

The high prices paid for naval stores during the colonial period and later directed attention to shortleaf pine. Some development followed, but it was not as profitable to the operator as longleaf pine, because the trees were more dispersed, operations more expensive, and the yield less. John Lawson, writing in 1714, listed pitch, tar, rosin, and turpentine as products of shortleaf pine in North Carolina.

MANUFACTURE AND PRODUCTS.

The uses of shortleaf pine are as varied as those of longleaf, and the two go together for many purposes, without preference or prejudice, but there are differences which sometimes lead to the choice of one or the other for certain special uses. Longleaf is considerably the heavier, though lighter in ash. It is also stronger and more elastic; consequently, when the architect desires timber to sustain pressure and withstand shocks, he decides in favor of longleaf; but in nearly all other situations shortleaf serves as well, and sometimes its lighter weight makes it more desirable than the other.

Furniture makers, who use yellow pine in considerable amounts, find shortleaf an admirable wood. It is worked into frames, goes into the interior of couches, tables, stands, and desks, and in the cheaper grades of similar articles it may appear as the outside visible part. The grain is handsome and shows well in natural finish or when stained.

Inside and outside trim for houses is manufactured from shortleaf pine. It is widely used for flooring and is recommended both by appearance and because of its wearing qualities. It responds readily to oils, wax, and other floor finishes and dressings. It answers equally well as wainscoting and ceiling, for chairboards, baseboards, brackets, molding, cornice, roseblocks, ornaments, carved work, spindles, balusters, railing, stairs, and panels. Window frames and frames for doors, and the doors themselves, and sash are largely manufactured from this wood. Plasterer's lath and shingles are products of shortleaf pine forests, and porch columns and porch flooring cause further demand upon the supply. Many of the large lumber mills of the South, particularly in Arkansas, Louisiana, and Texas, advertise shortleaf pine as a specialty, and are producing it in great quantities and in many forms.

Excelsior mills find the wood suitable for their purposes, and occasional use is made of it for pulp. Veneers of this pine enter largely into basket and box manufacture. Statistics showing the

output of veneer do not distinguish between different species of the southern yellow pines, and it is not possible to determine how much of the total belongs to shortleaf. The cut in 1908 in the United States classed as yellow pine was 42 million feet log scale. Red gum alone exceeded this amount. The veneer is manufactured into numerous commodities, among them berry baskets, fruit baskets, and vegetable barrels, boxes, and crates.

Slack coopers draw upon shortleaf for a large part of their material, but again statistics do not show the actual quantity supplied by this species.

The manufacturers of machinery, implements, tools, and apparatus make much use of shortleaf pine. It is specially valuable as wagon bottoms and cart beds, and for hoppers, drawers, boxes, chutes, and compartments in fanning mills, corn shellers, grain drills, thrashing machines, reapers, straw cutters, mowing machines, and in numerous other labor-saving machines and devices.

During 200 years it has held its place as material for ship and boat building, not only along the coast within a hundred miles or so of the supply, but in practically all ports of the country east of the Rocky Mountains where boat building is carried on as a business. It is fit wood for all parts of vessels from the frame to the mast, from rudder to prow. It is worked into decking, finish, cabins, lining, sides, railing, ladders, stairs, ceiling, seats, and nearly everything else of wood that is required in modern boat building.

LOBLOLLY PINE (Pinus tæda).

PHYSICAL PROPERTIES.

Weight of dry wood.—33.9 pounds per cubic foot (Sargent).

Specific gravity.—0.54.

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—73 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—12,300 pounds per square inch, or 77 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,628,000 pounds per square inch, or 77 per cent that of longleaf pine (Sargent).

Character and qualities.—Medium heavy, strong, and tough; grain coarse, even; annual rings variable, but mostly very wide; summerwood broad, resin more abundant than in shortleaf, less than in longleaf; resin passages numerous, not prominent; medullary rays numerous, obscure; heartwood orange yellow to light brown, the very thick sapwood light yellow or often nearly white; not durable, but takes preservative treatment readily; wood of the rosemary pine close grained, less resinous, lighter, with much thinner sap.

Growth.—Height, 70 to 120 feet; diameter, 2 to 4 feet.

SUPPLY.

Loblolly pine occurs commercially in Alabama, Arkansas, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, Okla-

homa, South Carolina, Texas, and Virginia, and is known under many names, among them old field pine, longshucks, black slash pine, frankincense pine, shortleaf pine, bull pine, Virginia pine, sap pine, meadow pine, cornstalk pine, black pine, foxtail pine, Indian pine, spruce pine, bastard pine, yellow pine, swamp pine, and long-straw pine.

Loblolly lumber which now reaches market is largely of second growth or has been cut on land where it formerly grew sparingly or not at all. It quickly takes possession of abandoned fields or tracts from which other timber has been cut, and it increases in size so rapidly that, where conditions are favorable, a tree 50 years old may cut three 16-foot sawlogs. Millions of feet of lumber have been cut from ground where old corn rows are still to be seen. Though the range of this tree has probably not been much extended since the country was settled, many areas and tracts have been partly or wholly taken possession of by it within that time. Perhaps no other species in the United States at present yields so large a lumber supply from second-growth forests. Its advance into abandoned agricultural lands in Virginia and North Carolina was noted by Michaux more than a century ago, and it has continued until the present time. In some localities the spread of loblolly pine was exceptionally rapid immediately after the Civil War, due to the abandonment of large areas on the southern plantations which before had been cultivated. Since that time the loblolly has spread from the primeval forest belts in Texas and in other regions west of the Mississippi into the prairies adjacent. Grassland which was treeless within the memory of living man has come up to pine seedlings. This has resulted from protection against fire. When the grass was burned yearly, as was once the rule, seedling pines could obtain no foothold, and the original forests bordering the prairies did well if they held the ground they already had.

The amount of loblolly pine timber in this country is not known. It covers 200,000 square miles, with a stand ranging from little or nothing in some parts to as high as 20,000 feet per acre or more in exceptional cases. Very large areas in almost all parts of the range of this tree are covered with more or less dense stands of timber in the sapling pole stage and which will not be merchantable before the expiration of 20, 30, or 40 years. Considering the stands of such young timber, it is hardly to be doubted that the area of fully stocked land is greater now than ever before.

Descriptions of the forests and of the country's resources contained in early histories and reports indicate that pine was not plentiful a short distance back from the coast of Virginia and North Carolina when the region was first explored. Hardwoods prevailed in many districts where pines pushed in later. However, at the beginning of

the nineteenth century the majority of the houses were of pine, which shows that if the wood was not originally abundant in the interior it spread there at an early date. Loblolly pine was cut by charcoal burners in large quantities, and was highly satisfactory for that purpose.[1]

EARLY USES.

There was an early trade in masts of rosemary pine cut in Virginia and North Carolina, and sticks of large dimensions were bought and sold. Rosemary pine was mature, well-grown loblolly, just as pumpkin pine in New England was white pine of large size and with exceptionally fine wood. The rosemary pine, as it was known and understood in early times, is very rare now. The regions producing it were long ago lumbered and the best timber culled out.

MANUFACTURE AND PRODUCTS.

As late as 1856 timbers of loblolly pine, which clearly belonged to the best class and were cut from the original forests, were hewed in North Carolina and sent through the Dismal Swamp Canal to Norfolk, whence they were shipped to New York. One cargo that was deemed worthy of special record was made up of squared timbers, with little or no sapwood and with solid contents ranging from 347 to 537 cubic feet each.

The wood parts of nearly all the buildings erected for the New Orleans World's Exposition were of loblolly pine cut in the Gulf region.

The use of this wood was greatly extended and its value increased when the custom of seasoning it in dry kilns became common. Prior to that time loblolly lumber frequently went to market green or imperfectly seasoned. It is largely sapwood, especially in medium-sized trees, and the water in it made it susceptible to attack by fungus, which gave a blue color to the wood and not only marred its appearance but induced deterioration. Thorough drying in well-constructed kilns removed the cause for that objection, and loblolly speedily won its way on its merits. Its range of uses is wide; it is sold in all the eastern and central parts of the United States and is exported to Europe and Central America.

A report of the woods used in Maryland for manufacturing purposes in 1909 gave first place to loblolly pine. In quantity it exceeded any two other woods, and in value was much above any other. Its nearest competitor in value was white oak. It exceeded all other

[1] In Robert Beverlye's History of Virginia, written 200 years ago, he referred to the promptness with which timber spread into open ground. There is little doubt that he had loblolly pine in mind when he said, "Wood grows at every man's door so fast that after it has been cut down it will, in 7 years' time, grow up again from seed to substantial firewood, and in 18 or 20 years it will come to be very good board timber."

woods combined (17 species were used) in the manufacture of boxes and crates, and was second in cooperage and basket making. Among the numerous commodities of which it forms part of the material or all of it are basket bottoms, vegetable crates, nail kegs, and boxes for fruits, vegetables, and bottles. It has a regular place in vehicle manufacturing for beds and bodies for wagons and carts, and in boat building for masts, siding, decking, lining, ceiling, cabins, and all kinds of finish and joiner work in skiffs, yachts, motor boats, and sailing craft. It is widely used by slack coopers. It is standard material for interior finish and is frequently employed on an equal footing with longleaf pine, which it closely resembles if pieces are carefully selected with regard to grain. It takes finish well, and if painted, as it usually is when used as weatherboarding, it wears well and needs repainting only at long intervals. It is excellent flooring lumber, and serves for practically all kinds of interior finish—window and door frames, ceiling, wainscoting, molding, railing, balusters, brackets, and stair work. Cabinetmakers work it into many articles, and it is seen in wardrobes, clothespresses, shelving, drawers, compartments, and boxes. It has no less a range of uses in furniture making, going for the most part into frames for couches, lounges, and large chairs.

A report of the wood-using industries of North Carolina in 1909 showed conditions similar to those in Maryland, in regard to loblolly pine. There more of it was used than of all other woods combined, the total being considerably more than 300 million feet. Practically every industry of the State that employed wood in manufacturing gave a prominent place to loblolly pine. Nearly 3 million feet were used for telephone cross-arms, it being practically the only wood employed for that purpose in the region. A comparatively large use in North Carolina is for tobacco hogsheads. Loblolly and longleaf pine aggregate 98 per cent of all the matched flooring manufactured in that State, but as the two woods are not listed separately in the statistics the proportion of each is unknown, except that most of it was loblolly.

RAILROAD TIMBERS.

Railroad companies buy large quantities of loblolly pine. It is used in car construction, chiefly for freight cars. It is employed in bridge and trestle work, though it does not rank with longleaf in strength or elasticity. It may be had in timbers that will compare in size with the best longleaf pine. Much is cut for crossties, but its tendency to speedy decay makes it unprofitable for that purpose unless it has been given preservative treatment. Loblolly pine is among the most easily treated timbers of the United States.

Loblolly mine props are largely used in the mines of the South and of Pennsylvania, and they are frequently given preservative treatment.

FUEL.

Few pines, if any, exceed loblolly in the extent of their use as fuel. Immense quantities are shipped as cordwood for domestic purposes and find markets in towns in the loblolly region, and also in cities as far north as Philadelphia. It has almost as wide a use for manufacturing purposes, particularly in brick burning, pottery kilns, and by bakers who demand a quick, hot fire.

CUBAN PINE (Pinus heterophylla).

PHYSICAL PROPERTIES.

Weight of dry wood.—46.1 pounds per cubic foot.

Specific gravity.—0.75.

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—Equal to white oak (Sargent).

Breaking strength (modulus of rupture).—16,400 pounds per square inch, or 102 per cent of that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—2,243,000 pounds per square inch, or 106 per cent that of longleaf pine (Sargent).

Character and qualities.—Very heavy, hard, strong, and tough; grain fine and straight; compact, annual rings wide, summerwood very broad, occupying fully half width of the annual growth; very resinous, conspicuous resin passages numerous, large; medullary rays numerous, rather prominent; color, rich dark orange, the sapwood lighter, often nearly white; durable.

Growth.—Height, 75 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of Cuban pine lies in Alabama, Florida, Georgia, Louisiana, and South Carolina; and among the names by which it is known are slash pine, swamp pine, bastard pine, meadow pine, pitch pine, she pitch pine, she pine, and spruce pine.

The Cuban pine made a late entrance into the lumber supply of this country. Long after nearly all other trees that are associated with it were well known, this tree had no botanical name, and those who made use of the wood generally supposed they were using loblolly pine or longleaf pine. It bears some resemblance to both, but the foliage would scarcely be mistaken for longleaf. It was finally distinguished as a separate species, and upon better acquaintance it was found to possess many properties which give it value at present and promise it a place in this country's future timber supply. It does not exist in large quantity, compared with some of the other pines. Its range is limited to the coast of South Carolina, Georgia, Florida, and along the Gulf to Texas. It is the only pine in southern Florida,

and this gives it special importance there. It is a Cuban and Mexican tree, and its geographical location suggests that it may have entered the United States by way of the Florida Peninsula.

No estimate of stand has been made for this pine. It is dispersed, and is not found in all parts of its geographical range. It is aggressive and, possessing the ability to grow in the shade, it is pushing its way into the longleaf-pine districts and crowding that species out of some localities. In order to do this it must have the assistance of man or fire. Where lumbermen cut the longleaf pine, or where fire clears the ground, the Cuban pine gets a foothold and is generally able to hold it against all comers. It grows rapidly, overtops the young trees or other species, and shades them to death. Its rapid growth gives it an advantage over most of its associates in contending against fire. If it escapes for a short time it attains size sufficient to enable it to endure scorching that proves fatal to the smaller seedlings of other species. It reaches commercial size much earlier in life than the longleaf pine, and this adds a value to it. Trees 40 years old produce turpentine, and before they are much older they attain sizes fitting them for lumber.

MANUFACTURE AND PRODUCTS.

The fact that the Cuban pine has gone to market with longleaf and loblolly without any distinction being made indicates that its range of uses is, or may be made, as wide as theirs. It is stronger than either, and has greater elasticity. Its wood resembles loblolly more than longleaf, because it is of rapid growth and has wide annual rings. It was long ago used for shipbuilding, but those who used it supposed it to be loblolly pine. Though employed in boat yards for a number of purposes, the largest use was for masts and spars. It has a place among interior finish materials and is manufactured into door and window frames, sash, wainscoting, stair work, molding, ceiling, and flooring. It is employed for general construction purposes, including siding, porch posts, balusters, and railing. It meets all the general demands upon yellow pine in furniture making, agricultural machinery, farm timbers, and bridge building. Car shops employ it for beams, frames, lining, siding, ceiling, and roofing for freight cars, and it ranks high among the pines as a crosstie wood, and much of it is bought for that purpose. Its rapid growth is a factor of value, because young trees quickly reach the required size. This pine grows much to sap. Young trees are more than half sapwood, but in old trees the heartwood has the larger place. The wood yields readily to preservative treatment, and its period of service is greatly lengthened, especially when made into ties and laid in damp situations.

It seems probable that the Cuban pine will hold an important place in the future supply of naval stores. Its ample yield, the comparatively short period required for trees to attain the necessary size, and the vigor with which they spread to new ground and maintain their hold upon it, indicate that the species will figure prominently in future operations in the South.

POND PINE (Pinus serotina).

PHYSICAL PROPERTIES.

Dry weight of wood.—49.5 pounds per cubic foot (Sargent).

Specific gravity.—0.79 (Sargent).

Ash.—0.17 per cent of dry weight of wood (Sargent).

Fuel value.—107 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—16,300 pounds per square inch, or 101 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,670,000 pounds per square inch, or 79 per cent that of longleaf pine (Sargent).

Character and qualities.—Very heavy, strong, brittle, coarse grained, compact; summerwood broad, forming fully one-half the annual ring; very resinous; dark colored, conspicuous; resin passages few, large; medullary rays numerous, obscure; color, dark orange, the thick sapwood pale yellow.

Growth.—Diameter, 18 to 27 inches, in typical stands, but the trees are frequently small; height, 35 to 75 feet in typical stands.

SUPPLY.

This tree is often called marsh pine by lumbermen, and is also known as meadow pine, loblolly pine, spruce pine, bastard pine, and bull pine. Its range is restricted to the region near the coast, from Albemarle Sound in North Carolina to the head of St. Johns River, Fla. It appears also on the west coast of Florida, and ranges near the coast westward to the vicinity of Pensacola. Estimates of quantity place it much below the pines with which it is associated, which are longleaf, loblolly, and Cuban. Pure, dense stands of small area are frequently found, but it also grows with other species on low, poorly drained soils. Sometimes it takes possession of ground so poor and damp that other trees compete with it feebly or not at all. It does not invade the dry, sandy tracts where longleaf pine flourishes. It is a waste-place tree, and contents itself with sandy, wet tracts where it is comparatively free from crowding. In late years, however, it has shown a tendency to extend its range. It is usually looked upon as an abundant seeder, but careful observation modifies this view. Trees are generally full of cones, but the crops of several years hang to the branches, and the actual quantity of seeds dispersed in a single season is much smaller than the abundance of cones would indicate. The seeds are small and their wings are of ample size to carry them considerable distances, for which reason

the species' power of reproduction is sufficient to maintain a foothold and to extend it when conditions are favorable. Its rate of growth is not much less than that of loblolly pine, when soil, light, and drainage are just right; but it is unable to extend its range as its associate pines do, and for that reason there is little prospect that the pond pine will ever much increase its commercial importance. When crowded in close stands it clears itself of branches and makes a trunk suited for the sawmill, but the amount of sapwood is excessive, surpassing loblolly pine in that respect.

MANUFACTURE AND PRODUCTS.

Pond pine has been cut, sawed, and sold as loblolly in all parts of its range. Lumbermen often do not recognize the difference. The growing trees look much alike, and, except for the cones, one may be readily mistaken for the other. The wood of the two species bears close resemblance and is difficult to distinguish. Pond pine lumber has given good service as planing-mill output, such as flooring, ceiling, and interior finish. It has gone to practically all the markets where loblolly has gone, though in less quantity. In the region where it grows it has been used since the settlement of the country as a plantation timber, especially for fencing about rice fields and on the islands and near the coast, where Sea Island cotton is grown. It does not last well in contact with the ground, but within limited areas its abundance has made it the most economical wood for certain purposes. That part of the cut which has reached the manufacturing cities has answered the purposes of cheap furniture, particularly for couches.

BY-PRODUCTS.

Pond pine was formerly not considered by turpentine operators, but when the abundance of longleaf pine near the coast began to fail operators experimented with this species and found it of considerable value, but not equal to longleaf. The quality of the product is satisfactory, but the quantity per tree is smaller, and it costs more to get it. The streak or wound in the bark which produces the resin must be renewed oftener, and the annual period of production is shorter than for longleaf. It is claimed, further, that the tree sooner succumbs to the injury from tapping.

SPRUCE PINE (Pinus glabra).

PHYSICAL PROPERTIES.

Dry weight of wood.—24.5 pounds per cubic foot (Sargent).
Specific gravity.—0.39 (Sargent).
Ash.—0.45 per cent of dry weight of wood (Sargent).
Fuel value.—53 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—6,900 pounds per square inch, or 43 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—637,000 pounds per square inch, or 30 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, weak, brittle; grain coarse; summerwood narrow, not resinous; resin passages few, not large; medullary rays numerous, obscure; color light brown, the thick sapwood nearly white; not durable in contact with the ground.

Growth.—Height, 75 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY AND USES.

Spruce pine is of minor importance, and apparently will remain so. This is due to scarcity and not to lack of value in the wood itself. It is softest of the southern pines and has been compared with white pine, and in some localities is known by that name. It is also known as cedar pine, poor pine, lowland spruce, and Walter's pine. The last name is in honor of its discoverer, who first described the tree in 1788. For seventy-odd years after that it was not recognized by any botanist, though the younger Michaux and others passed through the region where it grows. It is found near the coast of South Carolina and in restricted regions of Florida, Mississippi, and Louisiana. It nowhere forms pure forests, except in a few localities where second growth has taken possession of abandoned fields and in openings caused by timber cuttings. It is best developed in northwestern Florida, where trees reach maturity in about 75 years. Soon after that period the timber is apt to deteriorate through decay at the base and red heart at the top.

Though the wood is soft and has been compared in that respect with white pine, it resembles loblolly in appearance. The sapwood is thick, sometimes constituting three-fourths of the trunk of trees 75 years old. The wood shrinks about 10 per cent of its bulk in seasoning. Its fuel value is lower than the other southern pines, on account of its lack of resin. The want of resin excludes this tree from the list of pines valuable for naval stores and confines its value to its use as lumber only. A little of it is cut wherever mill operations are in progress within its range, but the lumber in the market is seldom distinguished from other pines that go with it.

SAND PINE (Pinus clausa).

PHYSICAL PROPERTIES.

Dry weight of wood.—34.75 pounds per cubic foot (Sargent)

Specific gravity.—0.56 (Sargent).

Ash.—0.31 per cent of dry weight of wood (Sargent).

Fuel value.—74 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—7,000 pounds per square inch, or 43 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—791,000 pounds to the square inch, or 37 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood medium heavy, soft, not strong, brittle; summerwood narrow and very resinous; resin passages numerous, prominent; medullary rays numerous, thin; color, light orange, or yellow; the thick sapwood ivory white.

Growth.—Best developed trees attain a height of 60 to 75 feet and rarely exceed 2 feet in diameter.

SUPPLY AND USES.

The sand pine is restricted in range and is usually small in size. A little of it is cut for fuel for local use about plantations, but for years it has given some service as masts for small vessels that fit out on the Gulf coast near where it grows. It is reported from only two States—northern Florida and southern Alabama. There is no reason to believe that the sand pine will ever become important. It withdraws itself to sandy dunes and barren ridges, where it frequently does not attain a height above 30 feet.

SCRUB PINE (Pinus virginiana).

PHYSICAL PROPERTIES.

Weight of dry wood.—33.19 pounds per cubic foot (Sargent).

Specific gravity.—0.5309 (Sargent).

Ash.—0.3 per cent of weight of dry wood (Sargent).

Fuel value.—71 per cent that of white oak (Sargent).

Breaking strength (*modulus of rupture*).—9,200 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—766,000 pounds per square inch, or 36 per cent that of longleaf pine (Sargent).

Character and qualities.—Medium light, soft, not strong, brittle; wide-ringed, compact; grain fine and even; summerwood narrow, very resinous; resin passages few, not prominent; medullary rays numerous, thin; color, light orange, the thick sapwood nearly white; not durable in contact with the soil.

Growth.—Height, 50 to 90 feet; diameter, 1 to 2 feet; in some parts of its range it seldom attains to that size.

SUPPLY.

Scrub pine is not an important timber tree in either quality or quantity. It is known as Jersey pine, shortshucks, shortschat, spruce pine, shortleaved pine, cedar pine, river pine, nigger pine, and New Jersey pine, and is found in a region embracing perhaps 100,000 square miles in Alabama, Delaware, Kentucky, Maryland, North Carolina, New Jersey, Tennessee, and Virginia. In many parts of its range the trees are small and few. In other portions, however, the growth is heavy and the trees large enough for some of the common and cheap grades of lumber. Estimates of the total available quantity have not been made. In many localities it is regarded as an encumbrance rather than an asset, yet that estimate of the tree's

value and importance does not do it justice. In 1909, in the State of Maryland alone, 17,000,000 feet of this lumber were put to use, and its value at the box factories where it was manufactured was $173,000. In quantity it stood fifth in the State, being surpassed by loblolly pine, longleaf pine, white oak, and cypress, while 48 woods were below it in quantity. No statistics have been compiled to show how much of this wood is cut and used in other States, but there is no reason to suppose that Maryland uses more than New Jersey or Virginia, and it is well known that considerable quantities are cut in many parts of its range. Though the annual cut of all woods in Maryland amounts to about 450,000,000 board feet, only one species, loblolly pine, exceeds scrub pine in quantity. It has not sprung into use in recent years, but has been of value for generations and for many purposes. It is known that the stand was considerable in New Jersey long before the Revolution, and that tar makers cut large amounts of it in that State, as well as in Delaware, along the eastern shore of Maryland, and in the southeastern corner of Pennsylvania. At the beginning of the nineteenth century scrub pine seemed to be gaining in area in New Jersey, and was spreading into the open ground. The species is best developed west of the Allegheny Mountains. Its growth is rapid, and it quickly takes possession of abandoned farm land, forming dense stands. These reach early maturity, and then give way to hardwoods, unless the entire stand is cut down, since it can not reproduce in the shade.

USES.

The earliest use reported for scrub pine was in tar making in New Jersey prior to 1750. In certain parts of its range, particularly in Kentucky, it is still employed to a small extent by tar makers. In Indiana it is manufactured into pump legs and water pipes. It is widely used for fencing, though not in large quantities. So far as available statistics indicate, the two most important demands upon scrub pine come from box makers and cordwood cutters. The box and crate industry in Maryland in 1909 took the whole cut in that State, besides several million feet shipped from Virginia. The boxes were of many kinds, including those for fruit, vegetables, fish, oysters, and canned goods of many kinds. The logs that go to the mills are small and generally knotty. They are ripped through and through and the boards are afterwards run through edgers. This tree is also cut to a considerable extent for pulp. The pulp mills of southern Pennsylvania and West Virginia employ rather large quantities, obtaining the supply mainly from Virginia and Maryland.

A large demand for cordwood is met by this pine. In fuel value it ranks below longleaf, shortleaf, Cuban, and loblolly pines, but it finds ready market in all the cities and towns to which it is shipped.

TABLE MOUNTAIN PINE (Pinus pungens).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.75 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.27 per cent of weight of dry wood (Sargent).

Fuel value.—66 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,000 pounds per square inch, or 62 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,159,000 pounds per square inch, or 55 per cent that of longleaf pine (Sargent).

Property and qualities.—Wood medium light, soft, strong, tough, compact; grain rather coarse; summerwood broad, resinous, conspicuous; resin passages numerous, large; medullary rays numerous, prominent; color light brown, the thick sapwood nearly white; not durable in the ground.

Growth.—Height, 40 to 65 feet; diameter, 18 to 40 inches.

SUPPLY AND USES.

Except in a few localities the table mountain pine is not abundant, though its range includes parts of Pennsylvania, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, Georgia, and North Carolina. It reaches its best development among the high mountains of eastern Tennessee, where on rocky ledges it sometimes is the prevailing forest tree, and in some parts of Pennsylvania it is rather plentiful. It is known also as prickly pine, hickory pine, and southern mountain pine. The timber is cut in all parts of its range, but is nowhere an important commodity. The largest recorded utilization of it has been in Pennsylvania, where considerable quantities have been made into charcoal. A few logs are sawed into lumber, which is never distinguished from other pines in the market. Some of it is cut for cordwood in Maryland and Pennsylvania, but its fuel value is below that of loblolly, pitch, or scrub pine. There is no reason to expect that the tree will ever attain greater importance than it now has.

PITCH PINE (Pinus rigida).

PHYSICAL PROPERTIES.

Weight of dry wood.—32 pounds per cubic foot (Sargent).

Specific gravity.—0.51 (Sargent).

Ash.—0.23 per cent of dry weight of wood (Sargent).

Fuel value.—70 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,300 pounds per square inch, or 64 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—838,000 pounds per square inch, or 39 per cent that of longleaf pine (Sargent).

Character and qualities.—Medium light and soft, strong, brittle, grain fine, uneven, and straight; annual rings rather wide; summerwood broad and distinct, very resinous; conspicuous resin passages numerous, large; medullary

rays few but prominent; color light brown or red, the thick sapwood yellow or often nearly white, not very easily worked, due to difference in hardness between spring and summer wood; fairly durable where used in contact with the earth.

Growth.—Height, 40 to 80 feet; diameter, 1½ to 3 feet.

SUPPLY.

The botanical range of pitch pine covers half a million square miles, but its commercial range is much less. It is in sufficient quantity for use in Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, and West Virginia. Among the different names by which it is known are longleaved pine, longschat pine, hard pine, yellow pine, black pine, black Norway pine, rigid pine, and sap pine.

No census of standing pitch pine in the United States has been taken, and the amount is unknown. No extensive forests exist, but it is dispersed widely, with small tracts of fairly dense stand. An average stand of 100 feet per acre would be a liberal estimate for an area of 100,000 square miles. The quantity used in Maryland in 1909 was about 625,000 feet, reported by manufacturers, and in Massachusetts about 887,000 feet.

The pitch pine is one of the trees which maintains its place in the forests in the face of adversity. It must have light or it can not grow; and in order to secure light it retreats to poor tracts and sterile ridges where few other species can exist. It meets poor success when it endeavors to extend its range into areas where other trees can overtop it. If ability to grow on poor land were the only factor in its favor, its struggle against adversity would end in failure. Its resistance to fire, however, is remarkable, and its seedlings frequently survive when all others are killed. On a certain tract it was found that fire killed 66 white pines to 1 pitch pine where size, number, and situation of the two species were similar. It has an advantage also in scattering its seeds, which are light and may be carried considerable distances by the wind, and which are released from the cones only in dry weather.

It is not probable that pitch pine will ever be extensively planted for the purpose of producing timber, for many other species grow more rapidly and promise better returns; but in certain localities, such as poor ridges and sandy tracts, it may pay to grow the tree.

EARLY USES.

Pitch pine supplied many needs of the early settlers, though in but few localities could it properly be classed as the most important tree. Over wide regions it was the chief source of tar, and it was not

unusual for each farmer to manufacture what he needed. Such manufacture was necessarily on a small scale and by crude methods. The tree's resin accumulates at the base of the branches, and the rural tar makers ordinarily made use of knots in preference to the clear wood of the trunk. Though the method used was a crude and simple process of destructive distillation, it produced a grade of tar which answered most purposes well. The tar's chief use among country people in early times was one which has now practically passed away. It was the best axle grease for wagons that could then be had, and the wagon without its tar bucket and its tar paddle, swinging from the rear axle, was seldom seen.

By subjecting the pitch-pine knots to a different treatment—a sort of steam distillation—shoemaker's wax was produced. This commodity was widely manufactured, but usually in very small quantities. The shoemaker was in every community and in most houses. The linen thread with which the home-tanned leather was sewed was rubbed with wax, and was then called "wax ends."

Lampblack was made of pitch pine long before it was made from natural gas, and the wood was one of the earliest put to use by charcoal burners. In the manufacture of charcoal the tar and other by-products were wasted, as no apparatus was devised to save them. The charcoal was in demand for blacksmith shops and iron furnaces.

Pitch pine had another extensive use in early times, which might seem unimportant when considered from the standpoint of the present. It was a substitute for the candle and the lamp at a time and in places where it was frequently impossible to obtain either. Splinters that burned with a steady flame afforded light in many a frontier cabin. The gathering of pine knots was as carefully attended to as the cutting of the winter's wood or the cribbing of the corn crop. The knots being rich in resin remained sound long after the prostrate trunk lying in the woods had decayed. That made the gathering of the knots an easy task. It was frequently done by driving an ox sled through the woods in the fall, where pitch pines had fallen and decayed, and picking up the knots that lay in rows on the surface of the ground.

Fagots, split from the bodywood of this pine, in early times and in regions where the trees grew often served for out-of-door light. Torches made of small split pieces bound together in bundles 4 or 5 feet long with hickory or yellow birch withes lighted the way on night journeys through the woods. Men who speared fish at night in the rivers and creeks had nothing better than the light from the pitch-pine torch. Hunters who went by boats along the shores of lakes and rivers "shined the eyes" of deer by that method.

FARM TIMBER AND BOAT BUILDING.

The builders of water mills in early times found that pitch pine was peculiarly well suited for wheels that worked in damp situations, and it was made into overshot, undershot, breast, and flutter wheels, being used for both buckets and spokes. Its principal virtue was its resistance to decay. For the same reason, timbers largely of heartwood were hewed for barn sills and sleepers and as foundation logs for various buildings. The wood was made into fences to a considerable extent, especially board fences with locust posts. It is occasionally so used still. Along the Atlantic seaboard boat makers drew supplies from pitch pine at a time when other woods were abundant; but the amount so used was not large in comparison with white pine, oak, and red and white cedar. In recent years considerable quantities of pitch pine have been used for boat building. It was in early use for ship pumps, the heartwood only being employed for that purpose. It was available in long stock, and, as with Norway pine, was liked for that reason by pump makers.

MANUFACTURING.

Bridge timbers and other beams for heavy construction are cut from pitch pine, though it is seldom highly recommended for uses which demand stiffness. Its botanical name, *Pinus rigida*, would seem to indicate that the wood's chief characteristic is stiffness, but the reference is to the leaves and not to the wood. In fact, in comparison with the pines, its elasticity is in the lowest rank, and not half that of longleaf. Some use has been made of it for railway ties. The chief objection to it, aside from its tendency to decay, which is common to nearly all pines, has been its poor holding power on spikes. Shipbuilders complain of it in the same way, and in certain parts of vessels where strain is great it is not advisable to employ it unless reenforced by oak or some other wood that holds spikes well. It has also been used extensively in Pennsylvania for mine props. In this capacity it comes into competition with loblolly and longleaf pine. In the mines the real test comes on durability. Pitch pine is more durable than loblolly, but less durable than longleaf.

One of the largest uses for pitch pine is for box and crate making. In quantity, however, it is far below other pines associated with it. In Massachusetts, in 1909, box makers used 600,000 feet of pitch pine and 263,000,000 feet of white pine, and in Maryland they used 615,000 feet of pitch pine and 70,000,000 of loblolly.

Pitch pine floors wear well, look well, and have long been in use. In Pike County, Pa., a pitch pine floor, laid with boards 2 feet wide

and 1½ inches thick, did service 160 years, and was still in such good condition that the boards were relaid for flooring in a new house.[1]

The wood answers well for door and window frames, ceiling, and other interior finish. Objection to the numerous knots which the wood contains is occasionally made. The knots are filled with resin and are often of much deeper color than the clear wood. Where handsome appearance is desired, therefore, pitch pine must be carefully selected, or it will not answer.

Makers of slack cooperage work this wood to advantage for barrel headings, crates, and nail kegs.

Vehicle manufacturers employ it for beds for wagons. Its largest users are said to be blacksmiths in small country towns, who make wagons as a side line and draw supplies from local sawmills.

It serves many purposes in furniture making, chiefly, however, as an inside material, since the knots are frequently considered as blemishes. It is given place in cupboards, ice chests, kitchen cabinets, tables, and as shelving and drawers in desks and clothespresses.

Pitch pine piles are employed in the construction of wharves and bridges. The wood is cut into excelsior and is made into pulp. It is widely sold for fuel in brick kilns, potteries, bakeries, steam engines, and for domestic purposes.

WHITE PINE (Pinus strobus).

PHYSICAL PROPERTIES.

Dry weight of wood.—24 pounds per cubic foot (Sargent).

Specific gravity.—0.385 (Sargent).

Ash.—0.19 per cent of dry weight of wood (Sargent).

Fuel value.—51 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,800 pounds per square inch, or 55 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,208,000 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, grain fine, straight and even; annual rings quite wide in young growth; compact; summerwood thin, not conspicuous, resin passages small, not numerous or conspicuous; medullary rays numerous, thin; color light brown, often slightly tinged with red, the sapwood nearly white; easily worked, susceptible of a good polish; heartwood durable in contact with the soil.

Growth.—Diameter from 4 to 6 feet, but larger trees were formerly found. In extreme cases diameters above 7 feet have been known. The height is usually from 75 to 120 feet, but individuals have been recorded nearly or quite 240 feet. It is doubtful if any other species east of the Rocky Mountains has produced specimens of equal height.

SUPPLY.

White pine occurred originally in commercial quantities in Connecticut, Delaware, Georgia, Illinois, Indiana, Kentucky, Maine,

[1] History of the Lumber Industry in America, J. E. Defebaugh, vol. 2, p. 563.

Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

The cut has probably exceeded that of any other species. Several timber trees have a wider commercial range, and at the present time two yield more lumber yearly—Douglas fir and longleaf pine—but white pine was the leader in the markets for 250 years. Though to-day the original forests of this species are mere fragments of what they once were, the second growth in some regions is meeting heavy demand. In Massachusetts, for example, the cut in 1908 was 238 million feet, and practically all of it was second growth. It is not improbable that a similar cut can be made every year in the future from the natural growth of white pine in that State. It might be shown by a simple calculation that if one-tenth of the original white pine region were kept in well-protected second growth, like that in Massachusetts, it would yield annual crops, successively for all time, as large as the white pine cut in the United States in 1908. To do this would require the growth of only 25 cubic feet of wood per acre each year, and good white pine growth will easily double that amount. The supply of white pine lumber need never fail in this country, provided a moderate area is kept producing as a result of proper care.

During the past 30 years the largest cut of white pine has come from the Lake States—Michigan, Wisconsin, and Minnesota. At an earlier period it was from Pennsylvania and New York, and still earlier the center of supply was New England. The output from the Lake States in 1908 was about 30 per cent of that in 1892. This decrease in output was due to depletion of the forests. The original pineries have largely been cut out, and though for some time there will be old-growth pine in the market, the bulk of the future supply must come from new growth. No large region of virgin timber remains. It is not to be expected that this country will ever again see the quality of this lumber it has seen in the past. The large, clear timber, such as once came from the northern pine regions, will never come from there again, because it was sawed or hewed from trees centuries old. It is too much to expect that forests of second growth will be permitted to attain that age or that the owners of trees will wait for them to attain a height of 150 and a diameter of 4 feet.

Estimates of the total quantity of this pine in the original forests of the United States should be regarded as approximations only. The area, excluding Canadian territory, was approximately 350,000 square miles. If it is assumed that the stand averaged 2,000 feet per acre, the total was 450 billion feet. That estimate would appear

conservative in view of the fact that a considerable part of the original pine forest produced 10,000 feet per acre and the actual amount of this pine marketed from Michigan, Wisconsin, and Illinois has exceeded 200 billion board feet.

EARLY DEVELOPMENT.

When the earliest colonists landed in New England they found the coast in most places densely wooded with white pine, and the valleys were filled with it. There are records, apparently well authenticated, of trees 240 feet high, and the extreme limit of 270 feet was claimed for one that stood on the site of Dartmouth College. The cutting of this timber began at once. Within 15 years after the settlement at Plymouth a cargo of masts was shipped to England, and from that time on the trade between New England and the mother country was maintained. Within 30 years after the landing of the Pilgrim Fathers the people of New England were sending white pine to Madagascar and Guinea in Africa, where it was exchanged for slaves for the Virginia and the West Indies trade. Exchanges of the timber were also made for other than human chattels. The Canary Islands, which produced wine, bought pine staves from Massachusetts and paid in wine, while Cuba, Haiti, and other sugar islands exchanged sugar for barrel and hogshead staves. A foreign trade, very large for that time, was carried on with white-pine timbers cut on the Piscataqua River, and in 1650 fears were expressed that the drain would exhaust the supply. This was within 30 years after the first permanent settlement on the New England coast, and at that time, as is now known, the primeval forests had scarcely been touched. The people had an erroneous idea of their extent, and many years after the first alarm was sounded there came another, which drew from Joshua McGee the reply that the cutting of a few hundred masts a year would make little inroad upon America's forests, which were, he said, "14 or 15 miles long and 300 to 400 miles broad."[1]

As late as 1706 there were only 70 sawmills on the Piscataqua River, which was the center of the white-pine operations. Yet they were numerous enough to have made serious inroads upon the forests had they been larger. They were of the sash-saw style, were operated by water power, and their capacity ranged from 1,000 to 3,000 feet each per day. All of them combined did not cut as much as one large modern mill. Sawing lumber by hand, as was the only

[1] Industrial Experiments in British Colonies in North America, E. L. Lord, p. 77. The word "long" was here used to denote longitude in its geographical sense, and "broad" meant latitude. The meaning was that the pine forests extended 300 or 400 miles north and south along the coast and 14 or 15 miles east and west, or inward from the coast. The manner of expressing the forest's extent shows how little was then known of its real dimensions.

method in England at that time, was carried on little, if at all, in New England. It appears not to have been the actual cut of the mills, but the waste, which constituted the serious drain on the forests. It was claimed that only one tree in four was saved, the others being destroyed. Only the best trees, and the best parts of the best trees, were taken. It frequently happened that half a log was cut off and thrown away as slabs. At Bangor the accumulation of slabs thrown into the river was so great that the channel was blocked, and passageways for vessels were cleared at great cost. Slabs were not the only part thrown into the river, for it is on record that so much good lumber was dumped in the stream that a boy in one summer was able to drag out enough to build a house. The markets where the early white-pine lumbermen found sale for their commodity demanded the highest quality, and the mill men met the demand with little regard for the resulting waste. In 1700 the New Hampshire lumbermen met, without recorded complaint, the demands of a market which insisted upon having white-pine planks 25 feet long and 15 or 18 inches wide, and for ship decks 36 feet long and 3 feet wide.

Early records are not available showing consecutive yearly exports of white pine from the different parts of New England, but isolated items are known. In 1671 the exports from New Hampshire totaled 200,000 tons of planks and pipe staves. In 1699 a timber trade began with Portugal, and it called forth most vigorous protests from merchants in England, who insisted that the colonists should do their trading through mercantile agencies in the mother country. The aggregate of the Portugal transactions does not appear to have been large, compared with modern lumber operations. One of the most vigorous protests was called forth when a New England ship captain at an expenditure of only $300 cleared $1,600 by carrying lumber to Portugal. His report of possibilities caused a sensation among the owners of white-pine lumber, and five vessels went to Portugal in one fleet carrying masts, spars, and other ship timbers. Reports of the exports to Portugal for six years, 1712–1718, when figured out by modern measurements, did not much exceed 2,000,000 feet, or one modern shipload—scarcely enough, it would seem, to justify an angry controversy between the merchants in England and the white-pine lumbermen in America.

More than a century ago the French botanist, Michaux, speaking particularly of New England, New York, and Pennsylvania, said that the white-pine lumberman kept 25 or 30 years in advance of the farmer, his meaning being that the land was stripped of its pine that long before it was brought under cultivation. He had in mind the constant western movement of settlements. His observation might need amendment before it could be applied in all parts of the white-

pine region and to all periods, yet, in a general way, the cutters of white pine have formed development's vanguard in the advance across the pine region from Maine to Minnesota. The white pine's lightness, which made it easy to float, was a factor in development which can scarcely be overestimated. Every navigable river or floatable stream was a highway for the transportation of the pine within reach of it. The enormous drives of pine logs once seen upon the rivers of Maine, Pennsylvania, and Michigan will probably never again be equaled anywhere. Had white pine been as heavy as red oak, lumbering operations in its region would have followed different lines, and the building of railroads would have preceded the marketing of the timber.

When the purchase of Louisiana in 1803 put an end to restrictions which had hampered trade on the lower Mississippi, one of the first commodities to feel and respond to the stimulus was the white pine on the head of the Allegheny River in northwestern Pennsylvania and southwestern New York. A fine quality grew in that region and was frequently known as cork pine. Rafts were sent down from the headwaters of the Allegheny River, 100 to 200 miles above Pittsburg, and made the long journey to New Orleans, more than 2,000 miles, measuring the windings of the river. Sales were made at $40 a thousand, which made the business highly profitable to the lumberman. The raftsmen were accustomed to return on foot from New Orleans to Pittsburg. Record exists of a white-pine raft which, when it passed Cincinnati, covered 2 acres, and contained a million and a half feet of lumber. The difference in early prices at Pittsburg, and at New Orleans was striking. A shipment at Pittsburg, a few years after trade began with New Orleans, sold at $5 a thousand, and half the pay was taken in window glass.

WHITE PINE LUMBERING.

The cutting of white pine has been a unique and interesting chapter in this country's industrial history. This does not apply to the marketing of the lumber so much as to the operations in the woods before the logs reached the sawmills. It is largely a thing of the past and has become history—a record of two and a half centuries of conditions never known before and which can never occur again. During two and a half centuries the cutters of this timber followed the retreating pine forest frontier westward from the coast of Maine to the source of the Mississippi. Conditions at the close of the period were very different from those at the beginning, but the white pine lumberman, with resourcefulness and ingenuity that challenge admiration, was equal to every demand upon him, met every emergency that arose, and again and again changed his methods to conform to changed conditions. Nowhere else has forest development exhibited so much

of romance and human interest. The cypress lumberman has been resourceful in his operations upon submerged lands; the yellow pine operators have cut the primeval timber harvest from a wide area; the cutters of white oak and yellow poplar have worked as long and have gone as far, but they have done it without stamping their individuality upon the history they have made. The men who have logged and milled the California redwood accomplished much on a small area, and over a wider region the Douglas fir has been the means of enormous development. But none of these compare with white pine in the absorbing and peculiar interest that pervades its history.

The first lumbermen on the New England coast had everything to learn by experience. They brought no forest lore with them from the mother country, for England was a land without a sawmill. They began with rude tools and on a small scale. There were no great lumber camps, but a multitude of small, individual enterprises. No large operations were carried on in New England in early times, though much business was done. White pine ship timbers were brought down to the sea by ox teams or were floated on the streams.

When the white pine operators reached New York and northern Pennsylvania, they found it necessary to carry on their work in a different way. They put the watercourses to more use, or used them over a larger region. Practically the whole State of New York was a continuous forest of white pine, and much of Pennsylvania was the same. The best of the timber near the lower Hudson River was cut very early by settlers, and that part of the stream was never much used for rafts and log drives. The stream could not be used in that way, for the current, because of the tides which ebb and flow twice a day, is too weak to carry floating objects down, unless the wind happens to be in the right quarter at the right time. Log drives on streams farther west became common. Floods were depended upon to carry the rafts or the loose logs in the streams. They were transported in that way from forests to the mills, sometimes a hundred miles or more. That made operations on a large scale not only possible but necessary. Some of the rivers of western New York flow through lakes where there is practically no current. When the drive of logs arrived at such a lake, they spread out upon the surface, and the wind drove them back and forth, scattering them and stranding many of them upon the shores. The lumberman's ingenuity was called upon to overcome that difficulty, and it was done by bunching the logs by passing a long cable around them and thus keeping them from separating and scattering. The logs were held in a body by that means, but the current was not sufficient to carry them down the lake to the outlet. To overcome that difficulty, windlasses were erected at certain points along the shore, and by means of ropes attached to the logs they were warped down the lakes, often against

head winds, until the current of the outflow caught them and carried them upon their journey.

The log drives and the rafting in the State of New York were small in comparison with those upon the rivers which flowed south through Pennsylvania—that is, the Delaware, the Susquehanna, and the Allegheny. The pine forests on the heads of those streams supplied large operators for many years. The Delaware was earliest in point of time, and Philadelphia was the chief market. The Susquehanna followed, with its sources in the great pine forests of New York and Northern Pennsylvania. Many of the head streams were too small and rough for rafting, and the logs were driven out on the crests of floods or by the aid of splash dams. These were built to impound the water and create artificial floods from time to time by opening the gates. When the logs had been carried to the larger streams they were either sawed into lumber or were collected in rafts to be sent farther down. The Susquehanna was regarded as a more difficult and dangerous stream than either the Delaware or the Allegheny. It had more rapids, more dams, sharper bends, swifter currents, and called for more skill and alertness on the part of raftsmen. The rivermen looked upon themselves as professionals, and were proud of their calling. Rafts usually floated 40 to 50 miles a day, and at night were tied to trees on the banks. Instances are on record of rafts from far up the Susquehanna which passed the length of the river and floated down Chesapeake Bay to Norfolk, Va., where the lumber reached a market. The passage down the bay was made with the assistance of the towing tugs.

The white pine forests of New York and Pennsylvania ended at Lake Ontario and Lake Erie, but beyond these lakes, in Canada and farther on in Michigan, Wisconsin, and Minnesota, they continued almost unbroken for hundreds of miles, wherever there was land. In that region of the lakes the largest and last of the primeval white pine forests of this country stood and there was carried on a system of lumbering which was in many ways unique and peculiar, with nothing else like it in our forest history. All the accumulated experience gained in 200 years among the pineries of New England, New York, and Pennsylvania was carried to Michigan, and was there turned to account in harvesting the vast timber wealth of that region.

Early lumbering there was on a small scale, as in other parts of the country, but when the demand came for the clear, soft pine of Michigan lumbermen were ready to provide it. Land was cheap, and for all practical purposes it seemed limitless. It was easy to acquire and passed rapidly into the hands of private owners or corporations. Cruisers, popularly known as "landlookers," were sent into the woods to locate choice tracts, which were bought up by capitalists. When a body of timber of sufficient extent was secured a

camp was established and the cutting began. Care was not always taken to procure lawful title. Timber stealing from public lands was common in that region, as it had been in New York and New England earlier and as it was in the Western States at a later period. The owner of a tract sometimes cut more timber from surrounding land than from his own.

Operations were usually on a large scale. The camp was an aggregation of buildings so situated that a large area could be worked from that center. It consisted of a cookhouse, bunkhouse, store, office, and stables. The number of men in a camp varied from 20 or less to 100 or more. The hours of work in winter were from daylight till dark, with extra hours for teamsters and cooks. The most of the work at such camps was done in winter, and the logs were made ready for the spring drives on the rivers. The cutting was done with axes and saws—chiefly saws. That was different from the early lumbering in New England, where saws were scarce and expensive and the trees were not only felled with axes, but the logs were cut off by the same tool, with extra chopping to square the ends. The peavy—a cant hook with a pike attachment—was in universal use in the Michigan lumber regions. Roads were cut in summer to be ready for winter. They led from different parts of the tract to points on the drivable streams where the logs were banked ready for floating.

The cold was seldom or never severe enough in the northern woods to keep the log cutters from their work, and from the first cool days of autumn till the snow began to melt in the spring the felling of trees and the hauling of logs were pushed with tireless energy. Camp competed with camp and crew with crew in turning out good work and plenty of it.

The landings along the streams were piled high with logs by the opening of spring. Millions of feet were ready for the freshets that followed the melting of the snow and the warm rains, and then came the crisis which was to determine whether the long winter's work was to end in complete success or partial failure. The winter's cut must be driven downstream to the mills. If the drive should lag and the falling water find logs still on the way and hung up on bars and ledges, the loss must be considerable, for white-pine logs left all summer are apt to be damaged by the discoloring of the sapwood or by the activity of worms. It was, therefore, a matter of importance that the logs should be safely delivered in the boom at the mill before the spring freshets subsided. The drive was the most trying time of the year. The men worked cheerfully from daylight to dark, nor grumbled if extra hours were required far into the night. It was a time of excessive toil, much excitement, and constant danger. Logs, piled high at the landings, might precipitate themselves with fatal

results upon the men who were skidding them into the river. There were jams in the streams to be broken, and the work was perilous. The men acquired skill in riding single logs down rapids, but sometimes the spiked shoes on which the rider depended failed at the critical moment or from some other cause he lost his balance on the whirling log and was thrown into the icy stream. He usually saved himself, but not always. It was a remarkable fact that some men who could not swim followed and took part in the log drives for years, escaping from every peril, while good swimmers sometimes lost their lives by drowning.

Many large operators built steam log roads from the forest to the mill, and did not depend upon the rivers to bring the logs down. That arrangement was more dependable than the spring flood, though less spectacular. Operations then went on the whole year through, both at the woods and at the mill. The steam log loader lightened the work of the cant-hook men by lifting the timber and placing it on the car, and many other labor-saving devices were introduced during the period when the bulk of the Lake States timber was going to market.

The decline in the output was as rapid as the rise. Year by year vast tracts of white pine were cut out and left barren, and the lumbermen moved to new locations; but the time finally arrived when no extensive new tracts remained and the golden age of white-pine lumbering passed into history.

SHIPBUILDING.

White pine has entered extensively into shipbuilding in this country ever since the first yards were established. In 1668 this industry had reached importance in New England, and by 1721 Massachusetts alone was launching annually from 140 to 160 vessels. Vessels were seldom or never made entirely of white pine, but for certain parts it was unexcelled. It is weaker than the Riga pine, which was its chief competitor one and two centuries ago, but it is lighter, and that was an important consideration. Masts other than white pine were seldom seen on New England ships. The wood was liable to quicker decay than the Riga pine at points of intersection with other timbers and below deck, but a preservative treatment was early put in practice. This consisted in boring holes in the tops of the masts and filling them with oil, which gradually penetrated downward, and it was claimed for it that it prevented decay. Not only were pine masts, yards, and bowsprits extensively used in American shipyards, but in English yards as well. The Revolutionary War interrupted exportations, but by 1789 shipments were again crossing the Atlantic, and houses in Scotland began to be finished in white pine.[1]

[1] European Commerce, J. J. Oddy, London, 1805.

For spars a length of 114 feet and a diameter of 38 inches were often specified. When Philadelphia became an important mast market, the timbers being floated down the Delaware River, it was customary to regulate the price by the diameter in inches 12 feet from the ground. A common price was $1.50 for every inch in diameter.

The figureheads for New England-built vessels were generally carved from white pine, and for this purpose the best parts of large, old trees were selected—called pumpkin pine, from the fact that the grain of the wood was highly homogeneous and could be cut in all directions, like a pumpkin, a quality appreciated by the carver.

Pine suitable for masts had become scarce by the beginning of the nineteenth century in many regions where excellent timbers of that kind were formerly cut. In 1805 Michaux did not see a single white-pine tree suitable for a mast for a 600-ton vessel during a journey of 600 miles from Philadelphia to Boston and beyond.

White pine has been and still is valuable for many parts of boat and ship construction, besides masts, yards, and bowsprits. In 1750 white-pine canoes, hewed from single trunks, were common at Albany, N. Y., and they were counted good for 8 to 12 years of service.[1] Yellow poplar was the chief canoe wood farther south and west. White-pine batteaux plied the Hudson, and doubtless other eastern rivers, before the French and Indian War. Albany was an important center of the white-pine lumber trade, and as late as 1806 the product was hauled on sleds from Skeensborough to that place, a distance of 70 miles.

At the present time the high price of white pine excludes it from some of its former uses in shipbuilding. Douglas fir from the Pacific coast is largely substituted in spars and yards. In smaller vessels, particularly in yachts, it is a favorite deck material, and it is used in fishing dories.

BRIDGES.

Within the white pine region it has been a valuable and much-used bridge timber. Its breaking strength is 45 per cent under that of longleaf pine of the South, and where strain is great it is inferior to longleaf for bridges. There are, however, many parts of bridge construction where great strength is not the chief requisite, and in such places white pine finds its best use. It has sufficient strength, if employed in adequate sizes, for any part of small and medium-sized

[1] The Indians of New York were using white-pine canoes when Europeans began to occupy the country, and had probably done so long before. The National Museum at Washington, D. C., has a portion of a pine canoe which is believed to be prehistoric. It was discovered in 1893, buried in mud near Lake Petonia, Chenango County, N. Y. It shows charred wood, and may have been hollowed by fire, a method often employed by savages in canoe making. The workmanship is crude, some parts of the shell being much thicker than other parts, and the canoe possesses none of the graceful lines so frequently associated with the handicraft of Indians. Other white-pine canoes made by New York Indians are in existence, but they do not date beyond the period of edged tools.

bridges, and in some notable instances it has been the chief or sole material of large bridges. It was used in the early structures spanning the Schuylkill River at Philadelphia, and the timbers in one of them were found in good condition after 37 years. The Delaware River at Trenton was likewise bridged with white pine, and it formed a large part of a bridge connecting Boston with Cambridge. The aqueduct over the Allegheny River at Pittsburg, by which the State canal crossed the stream, was built of white pine. It was 16 feet wide and 1,020 feet long, with 7 spans.

Many of the bridges in the interior of Pennsylvania and in West Virginia, by which the old pikes crossed the numerous streams, were built of white pine, and it was said of some of them that no man had lived long enough to witness their building and their failure through decay. Some of these structures were marvels in efficiency. Extra large timbers were unnecessary, and though slight in appearance, they carried every load that came during periods often exceeding half a century. They were roofed—usually with white pine shingles—and were weatherboarded with white pine or yellow poplar, and though painted only once or twice in a generation they stood almost immune from decay.

HOUSES.

An estimate made at the beginning of the nineteenth century by a traveler who had visited all the eastern portions of the United States was that 500,000 houses, exclusive of those in cities, were built of white pine.[1] He said that three out of four of the buildings of Pittsburg, Wheeling, and other towns on the Ohio River were wholly or largely of that wood. It was the material of rough construction and of inside and outside finish. It was sometimes stained to imitate cherry and mahogany, but was generally left in its natural color, with only a finish of oil, or with none. All through New England and New York it was a common building material while it was abundant. The finest residences and the humblest cottages employed it. It was manufactured into thin shingles and into the heaviest beams for churches and other large structures. When window sash was manufactured by hand no wood was better than the clear, soft, white pine. The carpenter could do more with it, and with less effort, than with any other wood. Many old houses of New England that were built before the Revolutionary War exhibit the excellent service white pine will give as interior finish. The Hancock House at Lexington, Mass., has panel work that was old when the opening battle of the Revolution was fought there. Some of the wood was finished in imitation of mahogany, and occasionally it is mistaken for that wood by visitors

[1] A. F. Michaux.

who judge it by its color only. The belfry where hung the lights which signaled Paul Revere to rouse the minute men on the morning of the fight was of white pine, clear, straight, soft, and of a rich color which a century and a third had not changed when the belfry fell.

The use of white pine for all classes of buildings is less than formerly, because the total cut in the country is not now half of what it once was. Increased cost has driven it from many places which it once held and cheaper woods have been substituted, yet it holds its own in higher class structures. It may be quarter-sawed, and presents an attractive grain. Large quantities of lath are made from slabs or inferior logs. Such material was once thrown away. Window sash made by machinery has taken the place of the handmade article of years ago, but the same high-grade lumber is demanded. White-pine doors meet a large and exacting demand. The light weight of the wood, its cheerful color, and its freedom from warping give it a value in almost every market. It is too soft for floors which are subject to excessive wear, but is excellent in certain situations. As siding, it has few equals. It paints well, holds its form, lasts a long time, and its appearance is attractive. The same properties fit it for ceiling, molding, panels, brackets, and railing. It is extensively used for shelves in cupboards, pantries, and fruit closets. Few woods equal it for outside and inside window blinds.

The white pine that grows in the Southern Appalachians is botanically the same as the northern species, but the character and the appearance of the wood are different. The homogeneous-grained pumpkin pine of New England and the cork pine of New York and Pennsylvania are not found in the South. The lumber from the southern tree is harder and is usually tinged with red. Its knots are generally round and sound, and often red. It never produces as much clear lumber as the northern pine, and the southern representative of the species seldom forms extensive pure forests.

SHINGLES.

The number of shingles made from white pine in the United States has been enormous. The three States, Michigan, Wisconsin, and Minnesota, produced 85 billion in 24 years. Shingles have been made of this wood since the earliest settlements of New England. For two centuries they were made by the slow process of hand work. The logs were cut into bolts by hand, rived with a frow, and the shingles were shaved with a drawing knife, the only other machine being a "shaving horse," a contrivance for holding the shingle while the manufacture went on. It was a slow process, and the man who could rive and shave 500 shingles in a day was fully up to the average of his craft. That many shingles sold for a dollar or two, depending upon time and place. The rustic shingle maker was an

expert in his line, and was supposed to be able to tell from a pine tree's general appearance whether it would "rive." He was at liberty, however, to test any trees he pleased by "blocking" them—cutting a large block out of the side of a standing tree to sample its splitting properties. If it did not suit, he passed on, leaving the blocked tree a prey to the next forest fire that would ignite the resin which accumulated in and about the wound.

The pioneer custom in Kentucky of killing buffaloes for their tongues was little more wasteful than the primitive white pine shingle maker's procedure. He used only a small portion of the choicest part of pine trees. The sapwood, the knots, much of the heart, and practically the whole trunk above the first 20 feet were left in the woods to rot. It was not unusual to sacrifice a 3,000-foot tree to get 1,000 shingles—throwing away fourteen-fifteenths and using one-fifteenth. The introduction of shingle-making machinery put a stop to that enormous waste, for the saws could make shingles of knots, slabs, tops, cross grains, and all else, from stump to crown. The old-style method of shingle making died hard, for the shavers opposed the introduction of machines, and declared the ruination of the country would follow so radical a revolution in a widespread industry.

It was sometimes found necessary to regulate by law the making of shingles by the old process. Thus, in 1783, an act passed by the Massachusetts Legislature provided that if a bunch of shingles fell 2 per cent short of the regulation length, the shingles should be seized and sold for the benefit of the poor. Under the old method every individual piece was counted as a shingle, and it must be approximately of the right length and width; when sawed shingles came in they might be any width, but every 4 inches made a shingle, and a piece a foot wide counted three shingles. They were packed in bunches, usually containing 250 shingles. When made by hand, two kinds were produced, known as "joint" and "lap." The latter were longer, with one edge thick, the other thin, and when nailed on the roof the edge of one lapped over the edge of another, like weatherboarding. The joint shingles were short, and were nailed edge to edge, like sawed shingles.

FURNITURE.

White pine is not usually classed as a furniture wood with oak, cherry, birch, maple, and mahogany, yet large quantities of it are made into furniture, and have been so made for 200 years. Articles of furniture wholly of this wood are now unusual, but it enters into many parts. It is often found as shelving in bookcases, cabinets, cupboards, presses, and as tops for kitchen tables. For drawing tables and boards it is still the most available wood. The cost of the

wood now excludes it from uses wherein its former cheapness placed it. The highest grade of white pine does not differ much in cost from black walnut and mahogany, though cheap grades may be had. A table of clear white pine would not fall much, if any, below the cost of one of oak.

The use of white pine in furniture making is chiefly historical. A hundred years ago it was employed for the interior of mahogany bureaus, chiffoniers, and tables. To-day a cheaper wood is used. In the pioneer days, within the pine regions, it furnished the bulk of the rural furniture material. Articles made wholly of it did not last long if they were subject to much wear or strain; but the wood was cheap, easy to work, and it was made into chairs, benches, stools, bedsteads, cupboards, presses, tables, and nearly all else that country houses contained. Oak was nearly always to be had when pine was used, and the preference given to pine was due, in most instances, to the greater ease with which it could be worked. The makers of church furniture find a number of places for white pine.

BOXES.

White pine holds its place remarkably well as a box material, in spite of the lessening supply and advancing price. It is lighter than the yellow pines and red gum, which are its hardest rivals. It nails much more easily than they, though it does not hold nails so well. Box lumber is generally of cheap grade, and second-growth pine is not excluded because of knots. In Massachusetts, in 1908, box makers used 263 million feet of second-growth pine, at an average cost at the factory of $16.85 per thousand feet. A large part of this pine was made into shoe boxes. Another large use for the wood is in the manufacture of boxes for the shipment of cloth and other merchandise from wholesalers to retailers. Shipping cases of this character are often of large size, requiring a hundred feet or more of lumber. Boxes for pianos and organs are often of white pine, and it is much in demand for fruit boxes and cases in which to pack chocolates and candies for shipment. Many tobacco cases are made of it, and it is, in fact, employed for boxes of so many kinds that particular reference to each class would be impossible. Many users of cheese boxes insist on having it, in preference to all others, because it imparts no taste. It is made into bottoms and tops, while the bent wood is ash, elm, or some other wood which is not apt to impart a taste.

COOPERAGE.

Large amounts of white pine are employed in cooperage, chiefly in what is known as straight-stave ware. That includes fish and lard buckets, washtubs, water pails, sirup buckets, keelers, piggins, churns,

and ice-cream freezers. In making fish barrels the sapling pine is used. This is a hard, tough, resinous, coarse-grained white pine, which has greater strength than the ordinary kind. Its character is supposed to be due to its place of growth on dry, elevated lands. White pine grows in various soils and situations, but the better the land the better the wood. The sapling pine is in a measure similar to the white poplar—a tough, inferior kind of yellow poplar which has grown on dry, poor land.

The cooper chooses white pine for a rather large class of domestic wares which are intended to contain articles of food. Among these are salt buckets, and small kegs or keelers to contain spice, cloves, tea, coffee, and similar commodities belonging to the pantry and kitchen.

A larger kind of cooperage calls for the same wood, and it is manufactured into silos and tanks. Some of the highest grade white pine is purchased by tank builders.

The wood is well fitted for barrel and keg heads and barrel bungs, and it serves as bottoms for bent-wood measures, and particularly as bottoms for axle-grease boxes.

FARM USES.

White pine has had and still has many uses about the farm in addition to those already enumerated. Vast quantities of it were built into fences while it was cheap and convenient. It was occasionally split for rails, though probably not often. It was not an ideal fence-post wood, because it did not last long, yet it was extensively employed for that purpose. Its chief importance in fence building was as sawed boards to be nailed to posts and as pickets for inclosing gardens and truck patches. Such a fence, under favorable conditions, would do service 15 or 20 years with slight repairs. Picket fences were formerly seen much oftener than at present, and the increased cost of white pine and yellow poplar, two excellent woods for that purpose, has doubtless had something to do with the partial disappearance of pickets around yards and gardens.

Parts of many farm machines are of white pine. For hoppers, sieve frames, parts of screens, boxes, drawers, seed holders, tool carriers, and many other portions of fanning mills, reapers, drills, tedders, thrashing machines, corn shellers, separators, and scores of other apparatus and appliances that are necessary to a modern farm it holds an important place. Its use for dairy machinery and appliances does not appear to be decreasing.

Many bee men prefer it to most other woods for hives and frames, and poultry men consider that its lightness fits it above many others as material for egg carriers, brooders, incubators, and other poultry-yard appliances.

WATER PIPES.

White pine was formerly made into mains and pipes for municipal waterworks, and some use of it for that purpose still continues. It was also employed in New England and New York mills for conducting water from ponds to forebays and wheels. The millwright constructed conduits of staves joined and banded, and forming a continuous piece without coupling—called broken-joint construction. Mains of that kind were seldom of great length, ranging from a few feet to 50 or 100.

The mains and pipes for town and city water supply were of a different kind. They were not of staves, forming a cylindrical trunk or conduit, but of logs with a hole bored lengthwise and fastened end to end with water-tight couplings. It is uncertain when pipes of that kind first came into use in the northeastern part of the United States. A few were employed at an early day, and they were doing service in many towns a century or more ago. Other woods were given a place, but in most instances where early records mention the kind of wood, it was white pine within the range of that tree, and occasionally outside of its immediate range. At Wilmington, Del., when 300 feet of pine pipe was taken up it was sound, though it had been in the ground at least 70 years, and no one knew how much longer. Pipes of the same kind were laid in the Jamaica Pond Waterworks, Boston, very early—probably about 1800—and in 1895 sections were removed in good condition, though they had been out of use many years. Pipe laid early in the century in New York and Philadelphia was undecayed after long periods of service.

When wooden pipes are kept full of water, under considerable pressure, the water fills the pores of the wood and prevents decay. To that fact is due the long service given by pipes made of woods which, in ordinary damp situations, decay in a short time. The pipes removed from the Jamaica Pond Waterworks were hardened on the outside and, when cut, the wood was fresh and bright.

About 1860 an improved method of making wooden pipe was introduced, and the product was called the "Wyckoff pipe," named from the inventor, A. Wyckoff, of Elmira, N. Y. Instead of boring the interior of a log as the ordinary auger does it, a machine was designed to take out a core. From this core a smaller was taken, and from that a still smaller, until a log was made into several pipes, ranging downward in size. The largest had an inside diameter of 17 inches and the smallest 2 inches. The waste was comparatively small. In 1905 there were 1,500 miles of such pipe in the United States, serving in municipal waterworks, manufacturing plants, and for other purposes. Michigan had more than any other State. The pipe is manufactured from a number of woods, but more white pine seems to have

been used than any other one wood. Forty-five miles of bored white-pine pipe was in service at one time in and near North Tonawanda, N. Y., with bore from 2 to 6 inches. After 17 miles of it had been 11 years in use, it was so satisfactory that 28 additional miles of the same kind were laid. The repair bill on the 17 miles for its eleventh year of service was only $7.52.

It is found advantageous to cover the outside of wooden pipe with tar and other water-proofing materials, chiefly for the protection it affords the metal bands that are wound spirally around it to give it strength; but experiments in coating the inside with water-proofing have ended disastrously. Pipes so treated have fallen to pieces from decay in a short time. That result is due to the exclusion of water from the pores of the wood by the interior coating. Considerably more water will flow through a wooden pipe than through one of iron or steel of the same size, because wood is smoother and friction less. This is true when both wooden and metal pipes are new, and the difference in favor of wood increases with age. The wooden pipe becomes smoother with usage, while iron and steel grow rough with accretions and the bore becomes smaller.

MISCELLANEOUS USES.

The facility with which white pine may be gilded fits it for picture and mirror frames. Its use for that purpose dates back more than a century.

Its use for heddles in cloth factories is a continuation of its employment for a similar purpose when nearly every country house and many in towns had looms for weaving cloth. It was the white pine's light weight that fitted it for that place, as the heddles had to be lifted or lowered for every thread that went into the woof. Its wide use for warping bars was for the same reason. That appliance, on which the thread for weaving woolen, linen, and cotton cloth was wound preparatory to putting it in the loom, was in most farmhouses at the period when weaving was done at home, but it has now practically disappeared along with its companion pieces, the rustic loom and the reel.

In the white-pine region, chiefly in the Lake States, the wood has a number of uses which are somewhat local, though of considerable importance, and are due largely to the convenience with which the wood may be had. Among such are bodies for bobsleds and sleighs. Some manufacturers prefer the wood above others for that purpose. It forms parts of windmills, beds for farm wagons, scales and appliances for weighing cattle and other live stock, vats of various kinds, sash and finish for hothouses, wood pulp, ice boxes, trunks, and spools on which to wind wire or rope.

In some of the sawmill towns of Michigan, where sawdust was superabundant, it was turned to accoount by paving streets with it, packing it down as a macadam road is built. The result was usually satisfactory.

When Minneapolis laid its white-cedar pavements it used 2-inch white-pine planking as a foundation on which to lay the blocks.

Between 1860 and 1870 Brooklyn paved some of its streets with white pine blocks which had been dipped in coal tar. They gave an average of 6 years' service. The city of Toronto laid a small amount of white-pine pavement in 1895, but found it a less satisfactory wood for that purpose than the northern white cedar.

No other wood equaling white pine has been found in this country for pattern making, though fairly satisfactory substitutes have been found in yellow poplar, redwood, and a few others. The pumpkin pine was the best, but that can no longer be had. The pattern maker wants a soft, solid material, and spongy woods and those of crooked grain and with knots will not do. Modern lumber yards supply little that meets the requirements, because old, mature trees grown in fertile soil—the kind that yielded pattern wood—are now very scarce. Pattern makers buy the frames of old mills and other buildings, erected and perhaps abandoned 20 to 40 years ago in Michigan and Wisconsin, and use the pine beams and timbers. The timbers taken from old mills and barns in northwestern Pennsylvania have been put to the same purpose.

White pine is one of the many woods manufactured into excelsior. It also furnishes a large part of the wood made into matches in this country. The quickness with which the coal dies after the blaze is extinguished is one of its principal recommendations for match making.

Its clear grain and the ease with which it may be cut makes it a favorite for scroll work and for cornice and capital decorations.

White pine is preferred to all other woods for the bodies of children's wheelbarrows and for hobbyhorses. The saving of a few ounces or pounds in weight in toys that are constantly in motion is an important consideration. The seats and other wooden parts of baby buggies and children's chairs, stools, carts, and swings are frequently of white pine.

Its softness and its light weight are properties considered in choosing it for drawing boards, cutting boards, and cloth boards, penholders, and toys of many kinds. Snow shovels, protected with metal cutting edges, are made of this wood. One of its competitors in this field is butternut, which is of nearly the same weight.

It is used in making shoe racks, a kind of truck employed in factories and large stores to carry shoes from one part of the building to another.

White-pine piano keys compete for first place with basswood. It has other uses in piano and organ making, and for some purposes is substituted for holly. It is an excellent wood for pipes in church organs, and for that purpose has been classed with the sugar pine of California and the southern white cedar of the Atlantic coast.

Golf-goods makers find it useful, though for very different purposes from those demanding hickory, ash, and elm. It goes into racket handles, where a light-weight wood is desired, and is frequently a competitor with red cedar for that purpose.

Caskets and coffins and the boxes in which they are shipped are manufactured of white pine in many instances. It is used also in making tobacco boxes and for the bottoms and sash of show cases.

BY-PRODUCTS.

Considering the great extent of the white pine forests and the important part their wood has played in the industrial development of the country, the by-products are few. As early as 1672 a law directed that the Plymouth Colony should make 10 barrels of tar a year. That quantity was very small, and probably pitch pine contributed as much as white pine. The turpentine or resin from the tree has been collected in a small way as a domestic remedy for rheumatism, ulcers, burns, frostbites, cuts, and bruises, but the medicinal value of the product is open to question. Sometimes the macerated inner bark was substituted for the resin, and a sirup made from it was believed to be efficacious in the treatment of whooping cough. A distillation from green cones was once believed effective in removing wrinkles from the skin if applied liberally as a wash. White pine sawdust is frequently employed in the manufacture of porous bricks. The dust is mixed with the clay or pulverized shale of which the bricks are made, and in the process of burning the heat destroys the sawdust and leaves the bricks porous. The conversion of white pine sawdust into gas for use in gas engines has been suggested, but no claim is made that it is better than the sawdust of California redwood or probably several other woods. The ground bark has been employed as an astringent, and the resin is recommended as an ingredient of cough sirup. In New England, and perhaps elsewhere, the shavings in planing mills are baled and sold as horse bedding in stables.

DISEASES.

The diseases and injuries to which the white pine is peculiarly liable have more to do with retarding or preventing the growth of wood than in damaging it after it has grown. Blight, either with or without fungus attack, occasionally injures growing pine in different parts of its region. The young trees have thin bark, and a

moderate forest fire damages or kills them. Wherever white pine forests have been cut fire has generally followed and killed the young pines that sprouted from seeds on the ground. The tree does not sprout from the stump, and when seed trees are removed and the seedlings already on the ground are killed by fire, as frequently happened in Michigan and elsewhere, the natural growth of pine in that district is at an end.

Direct injury to pine logs and lumber results from attacks of several insect enemies which may kill the trees or perforate the trunks of dead timber or damage sawlogs. Much injury was done from 1888 to 1893, from Maryland to North Carolina, by a bark beetle (*Dendroctonus frontalis*), but its ravages were not serious after that period. The pine sawyer—so named from the grating noise it makes as it eats its way into sawlogs—is a larva. There are several species. The white pine weevil bores the pith of twigs and makes special attacks on terminal shoots, thereby deforming young trees, which, on that account, though they may attain large size, are unfitted for high-grade lumber.

NORWAY PINE (Pinus resinosa).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.25 pounds per cubic foot (Sargent).

Specific gravity.—0.485 (Sargent).

Ash.—0.27 per cent of dry weight of wood (Sargent).

Fuel value.—65 per cent of white oak (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,605,000 pounds per square inch, or 76 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, not strong, moderately soft; grain rather coarse, even, and straight; compact; annual rings rather wide; summerwood not broad, light colored, resinous; resin passages few, small, not conspicuous; medullary rays few, thin; color light red, the sapwood yellow or often almost white; readily worked with tools; not durable in the soil.

Growth.—Diameter, 2 to 3 feet; height, 75 to 125 feet.

SUPPLY.

The commercial range of Norway pine lies in Michigan, Minnesota, and Wisconsin, in the United States, and in the Provinces of Canada. A small quantity is cut in New York, Pennsylvania, and New England. The tree is known also as red pine, hard pine, and Canadian red pine.

The supply of Norway pine in the United States and across the Canadian border is much smaller than formerly. No special demand has ever been made upon it, as was the case with white pine, yellow poplar, and black walnut, but it was put to some use from the first

settlement of the region. It was not found in extensive pure forests, as white pine was, and though its range covered 1,500 miles east and west and 300 or 400 north and south, the total quantity of Norway pine in the original forests was comparatively small. The supply now comes largely from Michigan, Minnesota, and Wisconsin, and Chicago is the central market. Exports which formerly found their way to England, but which are small now, went from Canada and Maine.

Norway pine grows with fair rapidity and is not exacting in its soil requirements. It insists, however, upon an abundance of light, and for that reason it is unable to force its way into areas where vigorous trees have a footing or to hold its own place successfully against trees which crowd it. This has, apparently, relegated it to poor, dry land, where competing species grow slowly or not at all. Experiments have demonstrated that Norway pine can be successfully grown in plantations. In rate of growth and form of bole it compares favorably with white pine in similar situations. It produces enormous numbers of very small seed. In spite of this fact it has not held its ground in regions where it was formerly abundant, and it is not counted upon to figure largely in the country's future supply of lumber.

The fact that Norway pine occupied the region with white pine, and was cut with it, and the lumber of the two species went to market together, and usually as one, resulted in relegating Norway pine to an obscure place far below its worth. White pine was the predominant timber of the region and attracted most of the attention of the buyers, sellers, operators, and all persons who were interested in the softwoods of the Lake States and the pine regions farther east. Nevertheless, Norway pine was an important source of timber. It was not used for all the purposes for which white pine was employed, but was for many of them. In presenting a list of its uses, the white pine list will answer with slight change, but with the provision that Norway pine fell very far below it in total quantity. In high-grade wood white pine was likewise ahead of it, but in the great middle and lower field of usefulness the two pines did service side by side.

SHIPBUILDING.

This wood has been put to use for various parts in shipbuilding in this country and in England, but the quantity used seems to have been moderate. A century ago it was much more common in the London market and in the dock yards on the west coast of England than it is now. Decking planks, occasionally 40 feet in length, were cut in Maine, Canada, or from timbers shipped across the Atlantic. Wide planks were impossible, because the Norway pine is small, and shipbuilders insisted on heart with no sapwood. This was necessary,

because the sapwood soon changed to a green color, due to fungus attack, and decay followed. The wood was used, and still is used, both in this country and in Canada and England for masts, spars, and deck plank. The wood is resinous and wears well. It has been described as midway between pitch pine and white pine. It is seen in cabins and fittings of vessels. When the Canadian French made a beginning in building a navy in the early history of that country they selected Norway pine for masts, while the forests contained practically unlimited supplies of other timbers.

The use of this timber for masts in former years when it was abundant was said to have been considerably lessened by the fact that trunks were seldom quite straight. Perfect sticks compared favorably with Danzic and Riga pine, and as late as 1875 its use in the British navy was reported.[1]

About 1895 the city of Toronto laid a number of woods in block pavement to test the lasting properties of different timbers in the untreated state. Norway pine was so used, and the results were favorable. White pine and Norway pine were rated equal—both were below northern white cedar, but above hemlock, sugar maple, beech, and slippery elm. The poorest results were shown by the elm.[2]

Pump makers drew supplies from Norway pine 100 years ago. Long, clear stock could be had without sapwood. The wood enters into car construction, including sills, frames, and the running boards on top of freight cars. It is sufficiently hard and strong for flooring, girders, joists, windmills, and bridge timbers. It makes good panels, but is occasionally objected to for doors and sash, because of its tendency to warp and twist. On account of scarcity, Norway pine has been obliged to retire from uses which it once filled, and its place has been taken by yellow pine and cypress. Norway pine has been suggested for posts, poles, and railway ties after receiving preservative treatment to hinder decay.

Makers of agricultural implements employ this pine for many parts, and it gives good service as sucker rods for windmills, and also as slats and fans and for water tanks.

BY-PRODUCTS.

The resin content of Norway pine is sufficient to attract the producer of turpentine and pine oil. At various points in Canada and in the United States distillation plants have operated on Norway pine stumps for these products. The resinous material is found principally in the lower portion of the tree; the part left in the stump is in fact richer in these materials than any other portion. Because of

[1] Timber and Timber Trees, Thomas Laslett.
[2] Street Pavements and Paving Materials, G. W. Tillson.

this fact Norway pine stumps have resisted decay, and now, 20 years following cutting, they are in some localities being pulled up and sent to the distillation plant. On arriving there they are washed clean of dirt and gravel, and then, by means of saws, "hogs," and shredders are reduced to small particles not over one-quarter inch thick and an inch or two long. By a blower process the rotten chaff and remaining dirt are separated out. The remainder is then ready for the steaming and extraction process by which the turpentine, oils, and rosin are obtained. The fibrous material, not being destroyed, is suitable for boiler fuel after these processes are completed. It is possible even that this material may be further utilized in making pulp for fiber board.

JACK PINE (Pinus divaricata).

PHYSICAL PROPERTIES.

Weight of dry wood.—29.7 pounds per cubic foot (Sargent).

Specific gravity.—0.48 (Sargent).

Ash.—0.23 per cent of dry weight of wood (Sargent).

Fuel value.—64 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—9,100 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,332,000 pounds per square inch, or 63 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong; grain fine; annual rings moderately wide; summerwood not broad, resinous, conspicuous; resin passages few, not large; medullary rays numerous, obscure; color clear light brown or rarely orange, the thick sapwood almost white; not durable.

Growth.—Height, 50 to 65 feet; diameter, 1 to 2 feet.

SUPPLY AND USES.

Among the names by which this tree is known in different parts of its range are scrub pine, gray pine, princess pine, black-jack pine, black pine, cypress, Canada horn-cone pine, chek pine, Sir Joseph Banks pine, juniper, and Bank's air pine.

There is little probability that jack pine will ever take its place among the important timber trees of this country. Its small size alone retires it to a secondary place; yet it has and promises to have a certain value, which entitles it to consideration. The tree has attracted considerable attention from foresters, who see in it the probable means of covering large areas of sterile, waste land on which few if any other trees will grow. Its commercial range includes the northern tier of States from Maine to Minnesota and extends as far north in Canada as Hudson Bay. It has been found efficient in fixing the drifting sand in certain parts of Michigan where the original forests were cut and burned, and at the same time supplying considerable wood and lumber to the industries of the region. Jack pine

is tenacious of life and grows in the face of adverse circumstances. In can maintain itself on sand and send its roots down several feet to moisture, while it thrives on land with the water table very near the surface. It is seldom uprooted even by the most violent winds. In early life its growth is rapid, but it matures early. Its average term of life is probably not more than 60 years. In that time it attains a diameter fitting it for railway ties, and a height of perhaps 50 or 60 feet.

Lumbermen cut the jack pine to a diameter of 4 inches, and saw the logs or poles into bed slats, or staves for nail kegs, or plasterer's lath. Thousands of cords of such logs go to the factories each year and meet a demand which must otherwise be met by wood of higher grade. Barrel and keg headings are made for the slack cooperage industry, and box factories draw supplies in large quantities from this wood. The larger logs make dimension lumber, while in some localities fences, including posts and boards, are made of this wood. It is an important source of fuel in many parts of its range.

Jack pine contributes to the country's pulp supply for the manufacture of paper. The pulp mills in the Lake States have made considerable use of it for this purpose, for which it appears to have about the same value as the scrub pine of Virginia and Maryland. It is used in both the mechanical and chemical processes of manufacture.

WESTERN WHITE PINE (Pinus monticola).

PHYSICAL PROPERTIES.

Dry weight of wood.—24.3 pounds per cubic foot (Sargent).

Specific gravity.—0.39 (Sargent).

Ash.—0.23 per cent of dry weight of wood (Sargent).

Fuel value.—52 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,700 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,356,000 pounds per square inch, or 64 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, but flexible, grain fine and straight; annual rings wide, summerwood thin, slightly resinous, not conspicuous; resin passages numerous, not large; medullary rays numerous, obscure; color light brown or red, the sapwood nearly white; as easily worked with tools as white pine; heartwood fairly durable in contact with the soil.

Growth.—Height, 100 to 175 feet; diameter, 2½ to 3½ feet.

SUPPLY.

Among the names by which this tree is known are silver pine, white pine, finger-cone pine, mountain pine, soft pine, little sugar pine, mountain Weymouth pine, and western white pine. The last name is most widely used, and distinguishes it from the white pine of the East. Its commercial range lies in California, Idaho, Mon-

tana, Oregon, and Washington. The largest cut is credited to Idaho, with Washington and Montana following. It grows in Oregon and California, but comparatively small quantities are cut there. It is found on the high parts of the Sierra Nevada Range, in some localities running up to altitudes of 10,000 feet or more, but the timber which grows at that altitude is not usually of a quality suitable for commercial purposes. The drain upon the forests of Idaho has increased in recent years, and in 1908 the cut of this pine exceeded the output of the year before by more than 36 million feet. Estimates of the total available supply in the United States have not been carefully made. The tree seldom grows in pure stands, though sometimes it predominates over associated species. Usually, however, it forms a low per cent of the forest in which it is found. Throughout the northern part of Idaho it makes the best growth of all species, and produces the bulk of the merchantable timber. The yield is greater also than that of any other tree. Mr. F. G. Rockwell, of the Forest Service, reports that in 1910 he found fully stocked stands of western white pine which contained over 130,000 feet b. m. per acre. The timber was all 140 years old, with an average height of 130 feet.

USES.

Western white pine is the most valuable species in Montana and Idaho. It serves fairly well as a substitute for the white pine of the east for a number of purposes. The western species is a little heavier, has a slightly higher per cent of ash, its fuel value is a little more, its strength is a little less, but in stiffness it surpasses the eastern white pine by 12 per cent. It is claimed that the eastern wood surpasses the western in durability.

The tree has been used within its range since the settlement of the region began. Trunks of large size in Idaho were occasionally made into split shakes or clapboards for roofing cabins and barns, but the wood was not liked as well for that purpose as cedar, and was pressed into use only when cedar was not to be had.

Considerable quantities of western white pine have been employed for mine timbers in that region, and in some localities it served as fence material in building stock corrals and in inclosing pastures and grain fields. Miners make use of it for stulls, lagging, flumes, water tanks, sluice boxes, water pipes, rifle blocks, rockers, and guides for stamp mills, for some of these purposes giving it preference over other timbers. The chief demands for it, however, are in distant markets, and comparatively small amounts are used in the region of production. It is a substitute for the white pine, and for that reason it seeks markets which the white pine of the East formerly held. It is bought by planing mills and manufacturing establish-

ments in the Mississippi Valley, and further East, for all classes of planing-mill stock, including flooring, ceiling, finish, siding, sheathing, shelving, doors, sashes, panels, columns, lattice, pantry work, and a long list of other forms. It is claimed that in some instances sash factories buy rough lumber in the Rocky Mountain region, have it shipped to Chicago or some other manufacturing center, make windows of it, and sell them in the region, perhaps the very town, whence the rough lumber came. This is made possible by the fact that glass is manufactured in the East, and the large sash factories locate near the glass supply. In some instances, but less frequently than in the case of sash, western white pine doors are made in distant cities and are shipped to the Rocky Mountain region to be sold near where the wood grew.

In the region where this white pine grows in proximity to merchantable Douglas fir and western yellow pine, it finds few buyers, because the other woods undersell it. In some instances the fir and yellow pine shipped to the Rocky Mountains from farther west are sold at a lower price than the white pine, and have crowded the latter out of its home market. It finds sale, however, farther east, where its chief competitor is the white pine cut in the Lake States. Thus the spectacle is presented of Pacific coast lumber entering the Rocky Mountain region and driving a native lumber from that market, and the displaced commodity, in its turn, competing successfully in the eastern market with a splendid wood of the East.

The western white pine has a wide market, won and held on its merit. It is shipped as far east as Boston, is in demand south of the Ohio River, enters the principal markets of the Central States, and is used for orange boxes in California, though the amount so used is not large. A considerable quantity of it has been exported to Australia. The total yearly output of western white pine lumber probably exceeds 150,000,000 board feet. Much of it goes into rough construction, but a large amount is used for other purposes. Factories making window blinds and shutters use this wood because of its light weight and its comparative freedom from resin, decay, and other defects. It finishes nicely and paints well. The same qualities recommend it for doors, window frames, and finish, both inside and out. It has been pronounced as good for picture frames, cabinet work, veneer backing, pyrography, baskets, and all classes of woodenware, and other plain and ornamental molding as the eastern white pine. It finds a place in undertaking establishments in the manufacture of burial boxes, in which the casket or coffin is placed. It has some use for shipping boxes for fruit and merchandise, but such use has not yet become important, because in the fruit-growing sections of the regions where this tree grows, as well as farther east, other woods are cheaper. Conditions very similar lessen its use for large packing

boxes in the manufacturing districts of the East. Cheaper woods grown near by supply the boxes in which merchandise is sent to market.

Pattern makers have drawn suitable material for their wares from western white pine. It meets the requirements fairly well, being soft, light, and easily cut across the grain as well as with it; but it is not usually considered the equal of the white pine of the East for this purpose, nor has it been able to compete as a pattern wood in the Pacific coast region with redwood, sugar pine, and western red cedar.

WESTERN YELLOW PINE (Pinus ponderosa).

PHYSICAL PROPERTIES.

Weight of dry wood.—29.4 pounds per cubic foot (Sargent).

Specific gravity.—0.47 (Sargent).

Fuel value.—63 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,100 pounds per square inch, or 63 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,209,000 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Character and qualities.—Rather light, not strong, grain fine, even, often twisted; annual rings variable in width, summerwood broad or narrow, resinous; resin passages medium and rather numerous; medullary rays not numerous, prominent; color light to reddish, thick sapwood almost white; not durable in untreated condition, but readily receives treatment.

Growth.—Height, 100 to 200 feet; diameter, 3 to 7 feet.

SUPPLY.

The total stand of western yellow pine in the United States in 1909 has been estimated at 275 billion feet b. m. Douglas fir was the only species showing a greater total, and the southern longleaf pine was next below. The four southern yellow pines together were estimated at 110 billion feet more than western yellow pine. White pine and Norway pine together amounted to only one-fourth the quantity of this western timber. In amount it is more than half the estimated combined stumpage of all the hardwoods in the United States.[1]

Few trees have a commercial range as wide as that of the western yellow pine. It has its best development on the Pacific coast, but it covers one-third of the United States. It is cut in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming, and is found to a smaller extent over a considerably wider area. In 1908 the largest output was in California, followed by Oregon and Montana in the order named. It is not always possible to separate the cut of this species from other pines of the region, because in many cases they are

[1] Forest Service Circular 166, The Timber Supply of the United States; also report of the Bureau of Corporations on the Lumber Industry, 1911.

reported as one. The tree has a number of names by which it is known in different localities, among them bull pine, big pine, long-leaved pine, red pine, pitch pine, heavy wooded pine, western pitch pine, heavy pine, foothills yellow pine, Sierra brown bark pine, Montana black pine, and California white pine. Some of these names are also applied to entirely different pines. Occupying as it does a range so extensive, with climates and soils differing, the western yellow pine does not present the same appearance and the same characteristics everywhere.

The enormous total supply of western yellow pine is not the only factor in its importance. It is practically the only timber in extensive regions, where its value can scarcely be overestimated. Next to incense cedar and the big tree, it is the most prolific seed bearer of the western conifers, and its seeds are sufficiently light to insure their wide distribution. This is one of the factors which gives the species its power to reproduce in the face of obstacles which stunt or kill some of the trees associated with it. The species is gaining ground within its range. It takes possession of vacant areas which have been bared by lumbering, fire, or other cause, and is usually able to hold its ground. In some cases it crowds out and kills the more stately sugar pine, because the latter succumbs more readily if its supply of light is seriously interfered with. It resists fire better than most of the forest trees with which it is associated, and this gives it a decided advantage. On the other hand, it suffers from insect enemies more than its associates, and in some localities this is a serious drawback. A beetle (*Dendroctonus ponderosæ*) sometimes destroys large stands. An estimate made in 1903 placed the beetle-killed timber in the Black Hills, S. Dak., at 600 million feet. That was twenty times the amount of this species cut in South Dakota in 1908. The enormous numbers of these beetles may be judged from the fact that 10,000 have been found in a single tree 8 inches in diameter, while a tree 30 inches in diameter has been estimated to contain 200,000.

The wood of the beetle-killed timber turns blue, owing to the presence of a fungus that enters through the holes made by the beetles. The bluing commences in the immediate vicinity of the holes and spreads rapidly through the wood, which is not damaged immediately, except that its color is objectionable, but decay is liable to follow the bluing. This pine occasionally suffers from the attacks of two other beetles, and much of the stand in small areas is killed. These are the mountain pine beetle (*Dendroctonus monticolæ*) and the western pine beetle (*Dendroctonus brevicornis*). A fungus called red rot sometimes does considerable damage to standing timber.

EARLY USES.

The western yellow pine was one of the earliest woods of the far West to be employed as mine props, and in many localities met the whole demand. The timber was sufficiently strong for the purpose, and the supply was usually abundant. Quartz mills for crushing the ores accompanied the underground mining operations, and in most cases steam engines furnished the power. The fuel was wood cut from the surrounding hills and canyons, and this pine supplied a large part of it. A single mine sometimes stripped hundreds of acres for fuel and props.

This timber performed an important part in railroad building on the western mountains and plateaus. The procuring of ties and bridge and trestle timbers was frequently one of the most difficult problems to be solved by the engineers. The forests of western yellow pine were drawn upon in many places where no other wood was available. In 1869, when the Kansas & Pacific Railroad was building, yellow-pine ties and bridge timbers were cut in Colorado and hauled by teams long distances eastward into Kansas. The Colorado Southern Railroad and the Denver & Rio Grande were built to a large extent with yellow-pine ties cut in Colorado.

Western yellow pine is coming into use among the electrical companies of southern California for telephone poles. The wood, which is sufficiently strong, had been ruled out in the past on the ground of insufficient durability. Methods of treating the butts of the poles with preservatives have been developed which are doing away with this difficulty. There are numerous stands of young timber throughout the range of the tree which are of just the right size for pole purposes.

During the Civil War the turpentine supply from the South was cut off, and the extraordinary demand for it and the high price stimulated the industry wherever yellow pine could be found in sufficient quantity. The extensive yellow-pine forests on the sides and summits of the Sierra Nevada Mountains, in Butte and Tehama Counties, Cal., were boxed and the business was profitable for a time. After the close of the war the southern forests became available and the Sierra Nevada pineries were abandoned by turpentine gatherers. The boxing caused great injury to the trees, and 40 years afterwards the trunks had not recovered.

MANUFACTURE AND PRODUCTS.

Westerr yellow pine has uses ranging from the coarsest construction to highly finished products. House frames, beams, joists, rafters, sills, sheathing, and studding are cut in all workable dimensions. It

is heavier and stronger than eastern white pine or the sugar pine of the far West. In some respects, chiefly in appearance, its wood bears considerable resemblance to both. The building of flumes to lead water along the faces of steep mountains and across sandy tracts, for floating timber, operating mines, and for irrigation, calls for very large quantities of wood, and yellow pine meets much of the demand. It frequently grows in the regions where the flumes are built, and for that reason it is the cheapest and most convenient material available.

It fills an important place as a fencing material, being occasionally but not frequently used for posts, and more often as boards and pickets. It gives good service as bridge timbers, and in many regions it is the best obtainable for bridge floors, though for this purpose it is inferior to nearly all species of oak and to Douglas fir and western hemlock. It furnishes sidewalks in many towns where wood is the only available material. As plasterer's lath it meets a large demand. In some regions, especially in Colorado, it is made into shingles.

This pine loses 2,000 pounds in weight per 1,000 feet b. m. in the process of seasoning. The lumber is widely exported, and reaches New Zealand, Australia, England, Ireland, Scotland, the Continent of Europe, and elsewhere.

Some of the finished products of the wood, notably sashes and blinds, are sold both at home and abroad as white pine. Planing mills that manufacture flooring and ceiling obtain some of their best lumber from western yellow-pine yards. It is often known as California white pine, and is made into several kinds of interior finish, molding, spindles, balusters, railing, panels, newels, brackets, chair boards, and frames. The wood is now shipped as far east as Wisconsin to be made into these products. It is one of the woods employed by pattern makers, though it is not generally considered equal to white pine for that purpose.

The match factories draw some of their supplies from this wood in northern California.

It is an important box material on the Pacific coast, and is widely used in packing establishments as far east as the Mississippi. It competes successfully with sugar pine and western white pine for boxes in which to ship fruit. Large quantities of lemons, oranges, apples, peaches, raisins, prunes, cherries, and other products of the orchards and vineyards of the far West and the Rocky Mountain region reach the consumer in boxes of this pine.

Slack coopers employ it in manufacturing buckets, kegs, and barrels for shipping vegetables and fruits, and it is also used for barrels to contain certain fluids, but not for alcoholic liquors.

SUGAR PINE (Pinus lambertiana).

PHYSICAL PROPERTIES.

Dry weight of wood.—23.0 pounds per cubic foot (Sargent).

Specific gravity.—0.37 (Sargent).

Ash.—0.22 per cent of dry weight of wood (Sargent).

Fuel value.—49 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,400 pounds per square inch, or 52 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,096,000 pounds per square inch, or 52 per cent that of longleaf pine (Sargent).

Character and qualities.—Very light, soft, not strong; grain coarse and straight; growth rings wide; summerwood thin, resinous, conspicuous; resin passages numerous, very large; medullary rays numerous, obscure; color light brown, sapwood nearly white; easily worked with tools.

Growth.—Height, 150 to 275 feet; diameter, 5 to 10 feet.

SUPPLY.

The botanical range of sugar pine extends from southern Oregon to Lower California in a comparatively narrow strip about 1,000 miles long. This pine is known also as big pine, shade pine, great sugar pine, gigantic pine, and purple-coned sugar pine. The tree is not cut for lumber in any considerable amount in more than half its range. In Oregon[1] it has been cut for lumber during 50 years, but the bulk of the output has been in California. In 1900 the cut was about 52,000,000 feet; in 1904 it was placed at 120,000,000; in 1907, at 115,000,000; and in 1908, at about 100,000,000. In the last year named Oregon supplied 7 per cent of the total. Practically the entire California output comes from the Sierra Nevada Mountains, and is cut in regions where the annual precipitation is 40 inches or more. The sugar pine thrives best on well-drained ridges and flats when the rainfall is plentiful. In Oregon its range comes down within 1,000 feet of sea level; but the limit gradually rises toward the south along the Sierra Nevada Mountains, until southern California is reached, where not much of the timber is found below an altitude of 8,000 to 10,000 feet.

It is difficult to estimate the total stand of sugar pine, since it never forms pure forests. It is regarded about the average if it constitutes 25 per cent of the growth in any region. The stand in California and Oregon has been estimated at from 25 to 30 billion feet.

[1] The discovery of the sugar pine affords the same interest to the botanist that the discovery of the planet Neptune presents to the astronomer—both were discovered before they were seen. David Douglas found seeds in the pocket of an Indian in Oregon nearly 100 years ago and at once saw that they belonged to an unknown tree. Following the directions given by Indians, he traveled many miles over mountains and valleys and was rewarded by discovering the largest pine in the world. He measured a fallen trunk that had been 245 feet high and 18 feet in diameter 3 feet from the ground.

The authors have been unable to learn of any trees observed in recent years which were anything near the size of that reported by Douglas.

If that turns out to be correct, it would supply for 250 years the output at the present rate. Those, however, who have witnessed the cutting of sugar pine during the past 20 or 30 years express doubts as to the continuance of the supply far into the future.

Sugar pine does not reproduce with vigor. The yellow pine (*Pinus ponderosa*), with which it is associated throughout nearly all of its range, is often able to crowd it out in clean cuttings, or in other places where young growth is taking the place of the old. The sugar pine's seeds ripen the second year, and the cones, which sometimes exceed 20 inches in length, fall the third year or later. The short wing with which the seed is equipped is too small to carry the burden far, and a sugar pine seldom scatters its seeds more than 200 feet. The failure of the sugar pine to reproduce is no doubt often due to squirrels, since in average years they consume most of the seeds, leaving few to germinate. The young trees endure considerable shade, which makes it possible for them to get a start when mixed with other species; but as they attain greater size they become intolerant, demand much light, and decline in growth if they do not receive it. Mature trees have a long, smooth trunk, with comparatively little taper and from which a high percentage of clear lumber may be cut. Young trees are liable to be injured or killed if they pass through a forest fire, but older timber is protected by its thick bark. Repeated fires, however, ultimately injure the trunks. Occasionally 5 or 10 per cent of a tree is wasted on account of a fire-hollowed butt.

Few sugar pines are uprooted by the wind, and the tree is comparatively free from attack by fungus. Very small trees occasionally suffer from mistletoe (*Arceuthobium occidentale*). The tree attains large size; specimens have been reported 20 feet in diameter and 300 feet high, but a sugar pine 10 feet in diameter is seldom seen even in forests that have never been culled, and a height of 250 feet is rare.

EARLY USES.

The use of sugar pine in California began soon after the discovery of gold. The early stockmen and ranchers did not draw much upon the mountain forests, for the double reason that they used little lumber upon their fenceless domain and that few roads then led into the mountains. Sugar pine grew well back in the ranges and was inconvenient if not inaccessible. The rapid increase of population following the discovery of gold called for buildings, and roof material was in demand. In California there were only two woods which answered the latter purpose well—redwood and sugar pine. The two timbers grew in widely separated regions, the redwood along the northwestern coast and the sugar pine on the mountains from 100 to 200 miles inland. The region near enough to the redwoods to draw supplies from them without railroads was beyond the reach of sugar pine;

while the people who could procure the pine were too far away from the redwood to make much use of it. For that reason there was not much competition between the two woods. Sugar pine roofed the shacks in a region 500 miles long.

The making of shakes became an important occupation on the Pacific coast. The shake is a split, unshaved shingle, usually 30 inches long and from 4 to 6 inches wide, and seldom more than half and often only a quarter of an inch thick. Thinness was regarded as a virtue rather than a fault so long as the shake had enough body to keep out the water. In early days the shake maker bought no timber, but took it without leave or license from Government land. The shake maker was wasteful. Under the most favorable circumstances the timber felled was seldom half used, and often after trees that would saw 10,000 or 20,000 feet of lumber were cut down they were left to rot in the woods because their splitting properties were poor. The men who worked at this occupation usually went in parties of two or four, made a camp in the pineries, and spent the summer within a radius of 200 or 300 yards. Four or five good trees afforded a season's work.

As the settlements increased in the valleys within 40 or 50 miles from the pineries, demand grew for lumber other than shakes. Primitive sheds and shanties could be made of shakes, including sides and roofs, with the earth for a floor, but more pretentious barns and residences demanded lumber, and early in California history the sawmill made its appearance. It did not, however, displace the shake maker, for he continued to provide roofing, and shakes served to cover substantial buildings on ranches and to some extent in the towns. But the shake makers were among the first to be singled out by the Government for the unlawful cutting of its timber, and the seizure of shakes representing a summer's work was not unusual. This discouraged those who were illegally cutting timber, and the maker of shakes lost half his foothold. Shake making from sugar pine, however, is still going on to some extent.

MANUFACTURE AND PRODUCTS.

Sawmills and other manufacturing machinery were early brought into use in the California sugar-pine regions. Some of the earliest sawmills did not cut sugar pine, but within four or five years after gold was discovered steam mills were located in the sugar-pine belt and were sawing lumber for flumes, sluice boxes, bridges, houses, barns, fences, and for other purposes. The quantity of lumber demanded by mines was very small compared with ranch and town demands. The pioneer millmen followed the example of the pioneer shake makers and cut convenient timber without obtaining the Government's consent. It would have been difficult at that time, however,

to obtain permission from anyone in authority, for the mountain lands, where the sugar pine grew, had not been surveyed.

More sugar pine was cut in that way in the Sierras than of all other woods combined, for it was lighter and softer than the yellow pine and better than the fir. Another species drawn upon largely, under the assumption that the Government would not protest, was the incense cedar for fence posts. The value of those two woods—pine and cedar—in the development of the region within reach of the Sierra timber belt can scarcely be estimated. Teams toiled up the steep grades to altitudes of from 4,000 to 6,000 feet, and hauled the fencing and building material from the mountain mills to the valleys below, often to a distance of 40, 50, and even 100 miles. That was before railroads brought in lumber from other regions.

Shingle mills quickly followed sawmills to the sugar pine forests, and shakes gave place to shingles on the better class of buildings. As the fruit industry began to develop, producing raisins and oranges, the box factory came to meet the new demand. At first, while good timber was plentiful and cheap, the box maker used all grades, but preferred the best; but later the price went up on the good grades, and the makers of boxes drew more largely upon lower grades. Some of the factories located in the timber belt and cut all kinds and all grades, manufacturing from the stump. Others bought cheap lumber from sawmills and carried on no logging operations. Sugar pine is a favorite wood for raisin boxes, not only because it is handsome and light, but because it imparts no taste or odor to articles packed in it. Some mills make a specialty of raisin boxes; others work their entire output into raisin trays—little portable platforms weighing a pound or more—on which the grapes are sun dried in the vineyards where they grow.

Sugar pine is a substitute for the eastern white pine for many purposes. The two woods are much alike in appearance and properties. White pine has about the same weight per cubic foot, has a slightly higher fuel value and considerably more elasticity, and is lower in ash. The lists of uses are much the same, but the amount of white pine manufactured in 1908 was thirty-three times that of sugar pine. The latter wood is shipped into the white pine region, where it sells at about the same price as white pine. It enters all the leading markets of New England and the Middle States.

Pattern makers still place white pine above all other woods in their business, but sugar pine is a close second, and some would make it equal. Large quantities of sugar pine are made into matches in California, and it serves the slack cooperage makers well, and also the manufacturers of woodenware. It has a place in boat building, largely for decking. Planing mills work it into molding, panels, posts, railing, and other interior finish, as well as blinds, sash, doors,

frames, and stair work. It is made into carvers' and cutters' boards, wash trays, and bakers' troughs. Its freedom from odor fits it for druggists' drawers and for the compartments in which grocers keep spice, coffee, tea, rice, and other provisions. The wood's straight grain qualifies it for service as pipes in church organs. Comparatively few woods are satisfactory for this purpose. Among the others are white pine and white cedar.

The claim has been made for sugar pine that it is preferable to white pine for doors and sliding sash because it shrinks and swells less, and holds its shape better. Boat builders hold that its behavior in salt water is equal to that of the best woods.

This tree is named from a product resembling sugar that forms where trunks have been injured by fire or otherwise. The principle is known as "pinite," and has been called "American false manna." It is believed to possess medicinal value. The claim that it is used to any large extent as a substitute for sugar is not well founded, since it possesses properties unfitting it for such use.

The seeds of sugar pine are about the size of peas, and are said to be the finest in flavor of all edible pine nuts. Their small size and their comparative scarcity make the gathering of them too tedious for anyone whose time is valuable, though Indians sometimes do it. The Douglas squirrel, however, is the greatest gatherer of sugar pine seeds, and in some localities his industry leaves few for other uses.

LODGEPOLE PINE (Pinus contorta).

PHYSICAL PROPERTIES.

Weight of dry wood.—25.5 pounds per cubic foot (Sargent).

Specific gravity.—0.41 (Sargent).

Ash.—0.32 per cent of dry weight of wood (Sargent).

Fuel value.—55 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—7,890 pounds per square inch, or 49 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,099,000 pounds per square inch, or 52 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong; grain fine, usually straight but sometimes twisted, annual rings usually narrow on account of the slow growth; summerwood narrow, not conspicuous, resin passages few, not large; medullary rays prominent, broad, numerous; color light yellow or nearly white, the thick sapwood often indistinguishable; easily worked because of evenness of texture, but too knotty to afford a large percentage of clear wood; not durable but readily receives preservative treatment.

Growth.—Height, 50 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of lodgepole pine covers parts of Alaska, Arizona, British Columbia, California, Colorado, Idaho, Montana,

Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. In different parts of its range it is known as tamarack, prickly pine, white pine, black pine, spruce pine, tamarack pine, and Murray pine.

This tree's wide geographical range, covering a million square miles or more, and its persistence in spite of repeated forest fires, make it an important factor in the present and future timber supply. It is not, however, in the first class as a producer of lumber, and probably never will be. It is of very slow growth, and usually a century or more is required to produce a trunk large enough for a saw log. Its chief value probably will be found in its ability to supply crossties, fence posts, mine props, telephone poles, and similar small timbers. The growth in its extensive range is by no means uniform, but is thick in some districts and very scattering in others.

Lodgepole pine profits by forest fires, even though its thin bark affords so little protection against heat that a moderate fire passing through a forest of this species frequently makes a clean sweep of all the timber. But nature has provided this tree with the means of perpetuating its species in spite of fire; in fact, the very fire that kills a lodgepole pine forest is a powerful agent in causing a new growth to spring up and take the place of the old.[1] The tree is a prolific seeder. It begins to produce fertile seeds when less than 10 years old and it continues to do so for two or three centuries, provided it is not killed in the meantime by fire.

The cones hang on the trees many years; the scales are sealed together with resin and the seeds are usually unable to escape. Fire softens the resin and the seeds fall out. They are not easily damaged by heat, though the cones may be severely singed, and the scorched cones hang on the fire-killed trees until the seeds have time to fall upon the mineral soil left bare by the fire. The following spring numerous seedlings cover the ground—as many as 138,000 having been estimated for a single acre. More than 17,000, 3 feet high, have been counted on a single acre. All of them can not grow to maturity, but after 80 or 90 per cent have been crowded to death the survivors still make a thick stand of tall, slender poles. They grow slowly to trees, and under favorable circumstances the best of them finally make saw logs. Nearly or all of the pure lodgepole pine stands occupy old burns. The tree reproduces to a small extent on unburned soil, but it can barely hold its own there.

The belief that the cones never open except after a fire is erroneous, but they open slowly and during several years, and when the seeds fall they are nearly all picked up by squirrels and birds. A forest fire assists reproduction in another way than by baring the vegetable soil and showering seeds upon it—it destroys the rodents,

[1] The Life History of Lodgepole Burn Forests, Forest Service Bulletin 79.

and removes the hiding places of birds which, in an uninjured forest, eat the seeds.

The lodgepole forest attains its greatest commercial value in from 100 to 150 years. There are more young stands than old, for the tree is gaining a foothold in many localities where it once was not plentiful.

The Government's estimate of the stand of lodgepole pine in the United States in 1909 placed it at 90 billion feet.[1] That made it seventh in quantity among the important timber trees, those above it being Douglas fir, the southern yellow pines, western yellow pine, redwood, western hemlock, and western red cedar. This shows that lodgepole pine occupies no minor position in this country's timber supply. It is ahead of white pine, hemlock, cypress, both the eastern and western spruce, and dozens of other woods which have long occupied important places in the lumber market.

WIGWAM POLES.

The Indians built their lodges or wigwams of poles set in a circle and bent inward, and tied together at the top, hence the name "lodgepole." The poles were from 10 to 15 feet long, and skins were spread over them for a roof and wall. No wood was better adapted to this purpose than the lodgepole pine, and to that fact the name is due. The Indians who lived within the tree's range, and also those upon the plains within a hundred miles or so, used lodgepole poles for wigwam supports. It was customary to cut and peel a supply in the spring when the tribe set out upon its summer hunt, and leave them to season until fall. They were then light, and were easily carried or dragged by squaws or dogs to the place selected for the winter camp. Poles of nearly the same thickness their whole length were abundant, and when dry were very light. A pole 2 inches in diameter and 15 feet long weighs only 7 or 8 pounds. Because of lightness, stiffness, and strength, the poles were employed in making the only land vehicle used by Indians in that region, a sort of sled. Two poles were tied together at one end and fastened to a dog's or horse's back, and the other ends trailed on the ground. The load was fastened on the poles and was half carried, half dragged.

EARLY USES.

The tall, slender poles and trunks in a lodgepole forest served the early white settlers as well as they had served the wandering Indians. One of the first things to be provided in establishing a ranch in the far West in the early days was a corral or yard in which to confine horses, cattle, and other stock. Lodgepole pine, when it could

[1] Forest Service Circular 166.

be had, was ideal timber for that purpose. Splitting was not necessary, for poles of suitable size were abundant. It would have been difficult to split the timber, for the multitudes of small knots pin the wood together like so many nails. The frontiersman built his fences and his sheds, stables, and sometimes his cabin of this wood. If it could be had at all it was usually plentiful, and many of the early settlers from the Rocky Mountains to the Pacific made their start in the new country by drawing liberally upon the lodgepole forests for ranch timbers and for fuel. This was especially the case in the stock districts among the mountains, for lodgepole pine is a mountain tree. In the valleys and near the base of the hills other species, such as willow, cottonwood, alder, and western yellow pine were more convenient.

MINE TIMBERS AND FENCE POSTS.

The early miners made large use of lodgepole pine timbers in their operations. As mine props it was cheap, substantial, and convenient. It is the chief timber employed for props, lagging, shafts, and stulls in Colorado, New Mexico, Montana, and Wyoming. The Rocky Mountain region contains many great forests of trees large enough for flumes and sluice boxes. However, the chief difficulty in cutting lodgepole for mine purposes is the large proportion of pieces too small for use. This is not so much the case where green timber is cut, for there the small trees may be left. A large proportion of this wood for mining purposes, however, is now cut from stands killed by fire from 10 to 25 years ago. In these operations only timber large enough for mine use is taken, while much that would ordinarily serve well for fence posts is left in the woods.

The National Forests contain much fire-killed lodgepole pine. In seeking to dispose of it the Government has tested its qualities in numerous ways, and it has been shown that the strength of the timber is not impaired as long as it remains sound, which may be for many years. The wood is so thoroughly dried out that it is in excellent condition for receiving preservative treatment. This opens a field for it for telephone poles and fence posts. The butts can be treated, and durable poles and posts made of what otherwise would be a comparatively quick-decaying timber. Since these products are required in great quantities in the Rocky Mountain region, a considerable market for the fire-killed poles has already appeared.

MANUFACTURE AND PRODUCTS.

Lodgepole pine is not listed separately in statistics of lumber cut, and it is not possible to determine what the annual cut is. It is known, however, that much lumber is sawed from this species in the Rocky Mountain region, particularly in Colorado, Wyoming, Montana, and Idaho. Its chief market is the newly established agricul-

tural communities of those States. Settlements have progressed rapidly in this region since 1900, and the demand has been correspondingly strong.

The need for fruit boxes in the young orchard of the western mountain region has opened a market for this lumber; and some of it is sold to manufacturers as far east as Chicago, who make boxes of it for shipping merchandise of various kinds.

Some of the lumber is shipped from the mills under the name of western white pine, and is used for interior finish. Its color and grain fit it for that purpose, but it is at somewhat of a disadvantage on account of the numerous small knots it contains. It gives good service in rough construction and for lath. Few western woods are better for pickets and fencing plank, and much of it is used that way.

Half a million lodgepole pine cross-ties are bought annually by railroads. This number is small in comparison with the total for the country, and the number has somewhat decreased since 1907. Conditions indicate an increase, however, before long, and the importance of this wood lies more in prospective than in present use. It is a wood which yields readily to preservative treatment, and when so treated it lasts many years. A number of railroads list it among woods for treatment and have drawn upon the supply for a long time. Forty years ago great numbers of lodgepole pine ties were cut in Wyoming. The western forests are adequate to meet very heavy demands for ties of this timber, and are so situated as to make the supply convenient by flume to a large mileage of railroad.

Preservative treatment promises greatly to extend the use of this wood for fence posts and telephone poles. In its natural state it is not enduring. But well-treated lodgepole posts are good for many years—perhaps as many as 20—and this will make them the equal of cedar. The wood lasts well above ground, and in some localities is used for fences that are supported on the surface of the ground by props, instead of being set in it. The long, slender poles that grow in dense forests of lodgepole are of convenient size for posts. Preservative treatment promises a greatly extended use of this timber for mine props also.

In Colorado and Wyoming much lodgepole pine was at one time made into charcoal for the smelters, but it is in less demand now, because the building of railroads has made coal and coke available.

JEFFREY PINE (Pinus jeffreyi).

PHYSICAL PROPERTIES.

Weight of dry wood.—32.4 pounds per cubic foot (Sargent).
Specific gravity.—0.52 (Sargent).
Ash.—0.26 per cent of weight of dry wood (Sargent).
Fuel value.—68 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,400 pounds per square inch, or 64 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,327,000 pounds per square inch, or 63 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood rather light, hard, brittle, wide-ringed, compact; summerwood narrow, very resinous, conspicuous; resin passages few, not large; medullary rays numerous, obscure; wood straw-colored, the sapwood pale yellow or nearly white.

Growth.—Height of 150 feet and a diameter of 25 inches are not unusual, while trees much larger are occasionally seen. On high mountains the average height is less than 100 feet, and the diameter less than 2 feet.

SUPPLY.

This tree's commercial range lies almost entirely in California and is confined to the higher Sierras, though it is found in southern Oregon and in the northern part of Lower California. It bears close resemblance to the western yellow pine, and over much of its range is associated with it, but extends higher on the mountains. It approaches within 3,600 feet of sea level and extends, in the south, 10,000 feet above. It is known by a number of names, some of which seem arbitrary or applicable to a restricted locality. Among them are peninsula pine, Truckee pine, pinos, black pine, black bark pine, sapwood pine, Sierra redbark, western black pine, and bull pine.

It would be difficult to make an approximate estimate of stand. Jeffrey pine is not scarce within its range, which extends 1,000 miles north and south and from 20 to 150 east and west. In many localities it passes for the western yellow pine, and in timber deals and lumber operations it is frequently cut, bought, and sold as such. Botanists, however, clearly distinguish between the two. The blacker and more deeply furrowed bark of the Jeffrey pine is the usual character by which lumbermen tell them apart.

Jeffrey pine is not aggressive in extending its range or increasing its stand. Its seeds have little wing area and never fly far. Neither are they abundant, and they are at still further disadvantage by being preyed upon by birds and rodents. The tree seems to be holding its own, but no more. Better protection against fire may help it to some extent.

USES.

A review of the uses of Jeffrey pine must be made under difficulty similar to a review of the uses of the Norway pine of the Lake States. The Norway pine is cut, milled, sold, and used with white pine, frequently without effort to distinguish it. The Jeffrey pine occupies precisely similar relations to the western yellow pine. There is, nevertheless, considerable difference between the woods of the two species. The wood is harder and coarser than yellow pine, and is more likely to warp if air-dried. It would be much more valuable for fuel than it is

at present if a market for it were within reach. It is full of pitch and burns quickly and brightly, but the range of the tree lies, for the most part, remote from towns and factories, and it furnishes comparatively little cordwood. A small quantity was formerly cut for poles on the margins of elevated glades and natural meadows of the Sierras, and was used for fencing corrals; but it was not liked for this use as well as the lodgepole pine, which very often could be had with no more labor.

ARIZONA LONGLEAF PINE (Pinus mayriana).

This tree's range lies in southern Arizona and New Mexico, and it thrives at lower altitudes than the western yellow pine. It occupies dry situations, and the trees are usually of less height and diameter than the yellow pine, but the woods of the two species are much alike. They are sawed, sold, and used without distinction.

CHIHUAHUA PINE (Pinus chihuahuana).

PHYSICAL PROPERTIES.

Weight of dry wood.—34.0 pounds per cubic foot (Sargent).

Specific gravity.—0.55 (Sargent).

Ash.—0.39 per cent of weight of dry wood (Sargent).

Fuel value.—72 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—11,600 pounds per square inch, or 72 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,048,000 pounds per square inch, or 49 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, rather strong, brittle, narrow-ringed compact; summerwood not broad, resinous, conspicuous; resin passages few, rather large, conspicuous; medullary rays numerous, thin; color clear light orange, the thick sapwood lighter.

Growth.—Height, 50 to 80 feet; diameter, 15 to 20 inches.

The Chihuahua pine is found in commercial quantity, though not in abundance, in southwestern New Mexico and southern Arizona. Although the logs average rather small for profitable lumbering, such lumber as is cut ranks with western yellow pine and is used for similar purposes. In addition to this, it has considerable local value as fuel and is employed about ranches for posts, sheds, and other timbers. It occasionally finds employment as posts, props, and lagging in mines. Estimates of stumpage for this species have not been made, but the supply is not large. The tree reaches its typical development at altitudes of from 5,000 to 7,000 feet above sea level.

APACHE PINE (Pinus apacheca).

This tree so closely resembles the western yellow pine in the region where both occur that some are inclined to consider it a form of that species. It is found in southeastern Arizona and is best developed and most abundant in the Chiricahua Mountains. So far as it is put to use, it passes for yellow pine.

ARIZONA PINE (Pinus arizonica).

PHYSICAL PROPERTIES.

Weight of dry wood.—31.4 pounds per cubic foot (Sargent).

Specific gravity.—0.5 (Sargent).

Ash.—0.2 per cent of weight of dry wood (Sargent).

Fuel value.—68 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—9,100 pounds per square inch, or 57 per cent that of long-leaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,153,000 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, rather brittle, compact; summerwood broad, very resinous, conspicuous; resin passages numerous, large; medullary rays thin, obscure; color light red, or often yellow, the sapwood lighter yellow or white.

Growth.—Height, 75 to 90 feet; diameter, 18 to 30 inches.

SUPPLY AND USES.

The range of the Arizona pine is restricted to the mountains of southern Arizona, where it attains its best development on rocky ridges from 6,000 to 8,000 feet above sea level. It is the prevailing forest tree near the summit of the Santa Catalina Mountains. In general appearance it closely resembles the western yellow pine, and the two species are frequently cut, milled, and sold in that region without distinction; but this holds only for the better grades of Arizona pine logs. Much of the timber is of small size and yields inferior lumber. The wood supplies a considerable local demand for fuel.

MEXICAN WHITE PINE (Pinus strombiformis).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.4 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—65 per cent of longleaf pine (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 61 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,154,000 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, hard, not strong, close ringed, compact; springwood thin, resinous, not conspicuous; resin passages large, not numerous; medullary rays numerous, obscure; color, light red, the sapwood nearly white.

Growth.—Height, 75 to 90 feet; diameter, 12 to 18 inches.

SUPPLY AND USES.

The Mexican white pine's northern limit is in southwestern Mexico and southern Arizona, and the tree is most abundant at altitudes of from 6,000 to 8,000 feet. Its range extends north and south through

Mexico to Guatemala. In New Mexico and Arizona the growth is scattering and comparatively scarce; the trees are frequently deformed through fire injury, and the trunks are inclined to be limby. Lumbermen who cut it at their mills are disposed to place small value upon it, not because the wood is poor, but because the supply is small. In appearance the wood resembles eastern white pine, but there is no evidence that it ever passes for it or is substituted for the eastern species. It is lumbered and marketed with western yellow pine. For that reason it is difficult to list its uses separately. This pine has contributed its share to the region's fuel supply and ranch timbers; but the demand for these has never been large within the tree's range, because much of the region is mountainous and sparsely settled. The tree is sometimes called ayacahuite pine.

SINGLELEAF PIÑON (Pinus monophylla).

PHYSICAL PROPERTIES.

Weight of dry wood.—35.25 pounds per cubic foot (Sargent).

Specific gravity.—0.57 (Sargent).

Ash.—0.68 per cent of weight of dry wood (Sargent).

Fuel value.—76 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—4,000 pounds per square inch, or 25 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—643,000 pounds per square inch, or 30 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood moderately light, soft, very weak, brittle, grain coarse, often twisted; annual rings narrow, summerwood thin, not conspicuous; resin passages few, not large; medullary rays numerous, obscure; color yellow or light brown, sapwood nearly white; not durable in the soil.

Growth.—Height, 20 to 40 feet; diameter, 12 to 15 inches.

SUPPLY.

The botanical and commercial ranges of this unique tree are coextensive. Wherever it grows it is put to use. The total quantity, considered as timber, is so small that in comparison with some other species, such as western yellow pine or Douglas fir, it is insignificant. Yet it is of such importance that the existence of the population—more in former times than at present—has often depended upon it. It is a product of the desert, of sterile plain, barren ravine, and bleak mountain. It maintains its foothold at an elevation of 9,000 feet, on the eastern slopes of the Sierra Nevada Mountains, and descends to a level of 2,000 feet in the hot Colorado Desert in California. It lives where the mercury falls below zero on wind-swept mountains, and it endures a temperature of 122° in the Mojave Desert. Its range covers portions of Utah, Nevada, California, Arizona, and Lower California, the most sterile and arid regions that can be found in this country. For that reason it has few neighbors of the vegetable

kingdom. A few trees associate with it here and there in its range, among them being mountain mahogany, California juniper, yucca, and sometimes a straggling white fir and Jeffrey pine.

It grows very slowly and can never be planted for the purpose of growing timber. A hundred years would be necessary to produce a fence post and 200 years for a railroad tie. Nothing larger than a crosstie need ever be expected, though in exceptionally favorable circumstances a small, short saw log might be produced. The difficulties which beset the seeds and the seedlings before the young pine finds itself safely established in the sterile soil and inhospitable climate are apparent in the fact that scarcely one seed in ten thousand—possibly not one in a million—becomes a tree. The seedling demands shade to protect it from the scorching sun and withering winds, but the parent trees, almost destitute as they are of foliage, afford hardly the shade which a thin lattice work would give. The large trees are so intolerant that they will endure no crowding, and a forest of these trees casts only a pale, penumbrous shade, and in it the seedlings must struggle for their lives, and the struggle ends in death for the most of them.

The tree has several names, but singleleaf piñon has been proposed as best suited, since it is the only pine in this country with single leaves. They are dispersed sparingly over the twig and are curved to a form resembling the old-style shoemaker's sewing awl. It has been described as the tree with awls for leaves. It is perhaps the most fruitful tree in the world, in comparison with the resources and material at its command.

No estimate can be offered of the quantity of singleleaf piñon timber. It is scattered over an area of 100,000 square miles, but pure stands of considerable density are few. It can scarcely be measured in the way other timbers are measured, for few of the trees will yield a single short saw log of small size. The trunks are branched and squat, like sprawling apple trees. They run to limbs, and the yield of an acre or a tract would have to be computed as cordwood rather than as saw logs or even crossties. The tree is sometimes called Fremont's nut pine, gray pine, Nevada nut pine, and Mono mast pine.

LOCAL USES.

The uses of the wood of the singleleaf piñon are local. It is seldom or never shipped out of the region where it grows, but in that region it is of supreme importance. Without it the wheels of industry would stop in many a remote locality where a few men are holding out against adverse circumstances in an effort to develop mining claims, or small tracts of ranch, or farm land surrounded by inhospitable wastes.

In a few instances this pine has been used for crossties. Railroads cross the region in a number of directions, and necessity sometimes compels the builders to employ the crooked trunks for temporary ties and for short timbers in trestles. A more important use of the wood is for mine timbers. Short pieces can frequently be employed to advantage in shoring up stopes and strengthening the walls and roofs of tunnels and galleries. Some of the most productive silver mines ever worked in this country, and many gold mines also, have been located in this pine's range, and the miners put it to every use where it could possibly be made to serve. It was, and is, the main dependence for fuel in large districts. It provides heat for boilers that pump the mine shafts and hoist the ores. The cooking, baking, laundry work, and the warming of homes and camps are possible in many places only by utilizing the singleleaf pine that covers the mesas and ridges.

An industry that is important, though not large, is the burning of charcoal. Portable blacksmith shops are carried into remote canyons or high up on mountains where prospectors are developing mines, and the only fuel for sharpening, mending, and tempering tools is the charcoal burned from this pine in the rude pits built near the source of the wood supply. As a charcoal material on some of the most rugged mountains, it sometimes goes to the pit with the western junipers which maintain a foothold on plateaus and ranges so high that even the pine can not grow there, but the charcoal burner brings them together.

The singleleaf pine is not an ideal farm timber, and it would seldom be put to that use if anything else could be had; but the circumstances which cause it to be employed in mines lead also to its use on ranches. Some timber must be had, even on the most unpretentious desert homestead, and the pine is cut for fences and sheds. It serves also for repairing wagons and farm machines.

BY-PRODUCTS.

This tree has one by-product which gives it a peculiar importance. Groves and stands of the singleleaf pine are known locally and not unaptly as "the redman's orchard." Its phenomenal production of fruit has been spoken of. Every year is not a fruitful year, but a failure of crop is unknown, and when good years come, as they do quite often, the yield is tremendous. It has been said that in total production in a good season this pine's nut crop probably exceeds California's wheat crop.[1] As it is a desert tree, growing on wastes and among remote mountains and scattered over tens of thousands of square miles, in regions with few inhabitants or none, very few of

[1] The Mountains of California, p. 222, John Muir.

the nuts go to supply human needs. Possibly one bushel in a thousand is gathered. It is an important article of food with the nomadic Indians who roam through the region, but can scarcely be said to occupy it. They save all the pine nuts they can while the crop is falling, but the harvest is short. During a month or two the Indians live in luxury and for the rest of the year they must depend upon something else, though the region produces little other food that the Indians can appropriate. This statement applies more to the region before white men began to develop it than now. Had the nut crop been continuous during the greater part of the year the region would have supported a large Indian population, but it sufficed for a few weeks only, and famine followed. The Indians stored the nuts to a limited extent, but they could not, or at least did not, lay by enough for the rest of the year.

The opening of the nut season brought Indians from neighboring regions to partake of the bounty. A single Indian—generally the women did the work—would gather 30 or 40 bushels. The harvest time was a perpetual feast. The nuts were roasted or eaten raw. The Indians preferred them roasted because the strong oil in the nuts soon cloys the appetite if eaten raw. The nut gatherers carried on an interesting though not very large commerce with their countrymen outside the nut district. In some instances the nuts were carried 100 miles to be exchanged for fish or some other product that the native traders could use for barter.[1]

The Indians who gather nuts do not confine their commercial transactions to trade with other Indians, but carry on considerable business with white people. The nuts are sold in thousands of stores between San Francisco and Denver, and North and South. They resemble shelled peanuts in size and appearance and are eaten in the same way. No one knows how many bushels are sold yearly, but in the aggregate the quantity would be surprising if known. The nuts are not bought for human consumption only, but where they are plentiful and cheap are fed to horses, which seem to prefer them to grain. Burro pack trains, carrying supplies for sheep herders and miners in the region, sometimes get little other provender for days together.

When the mines at Virginia City, Nev., and elsewhere in that district were booming, long before railroads were within reach, the problem of feeding the thousands of miners was extremely difficult. Ranchmen in California, west of the mountains, were accustomed

[1] An interesting exchange of commodities formerly took place, and possibly has not entirely ceased, between Indian tribes occupying different sides of the Sierras. West of the mountains, in Fresno and Madera Counties, Cal., Indians gathered acorns, and the women, burdening themselves with 2 or 3 bushels each in baskets strapped on their backs, carried them across the Sierras, 125 miles, following almost impossible trails and passing the summit at 12,500 feet. Arriving on the east side, they exchanged the acorns for pine nuts, which they carried home, the journey occupying about 20 days.

to drive hogs slowly across the Sierras during the late summer, arriving in the pine belt about the time the nuts began to fall. The herds fattened two months on the abundant mast and were then ready for market. This occurred in the region of the Mono Indians, and the name Mono mast pine was applied to the tree.[1]

Although the nut harvest in the aggregate is enormous, and a proportion so small as to be almost negligible is ever gathered by man, yet in certain localities former plenty has been changed to little or nothing, due to the cutting of the trees for fuel and mine timbers. The white man's and the Indian's interest clashed many times on the desert frontier, the red man defending his food tree and the white man bent on taking it away.

MEXICAN PIÑON (Pinus cembroides).

The Mexican piñon has its northern limit in southern Arizona and New Mexico, where the trees are comparatively numerous, but so small that they contribute scarcely any saw timber, though something to the region's fuel supply and to the needs of ranches. Its average height is only about 30 feet and its diameter less than 1 foot. The nuts have hard shells, like those of gray pine, and are edible. The tree is sometimes called nut pine, piñon, and stone-seed Mexican piñon. The wood is light, soft, very close ringed, compact; bands of small summer cells thin, not conspicuous, resin passages few, small; medullary rays numerous, obscure; color light, clear yellow, the sapwood nearly white. The wood's weight is 40.58 pounds per cubic foot, specific gravity 0.65, and ash 0.9 per cent of dry weight of wood. (Sargent.)

PIÑON (Pinus edulis).

PHYSICAL PROPERTIES.

Weight of dry wood.—39.8 pounds per cubic foot (Sargent).

Specific gravity.—0.64 (Sargent).

Ash.—0.62 per cent of weight of dry wood (Sargent).

Fuel value.—85 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—6,300 pounds per square inch, or 39 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—604,000 pounds per square inch, or 29 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood heavy, hard, weak, brittle; annual rings very narrow; summerwood thin, not conspicuous; resin passages few, small; medullary rays numerous, obscure; color, light brown, the sapwood nearly white; moderately durable in contact with the soil.

Growth.—Height, 10 to 25 feet; diameter, 6 to 20 inches.

[1] The herding of the hogs on the pine mast was often attended with danger. The Indians of the immediate vicinity resented the invasion, and with reason, since their food supply was being devoured by the hogs. They retaliated by stealing as many of the swine as possible, and sometimes offered violence to the herders. Bears of large size and savage nature also left off gathering nuts and fell upon the swine with appetites so voracious that the herders were compelled to wage constant war upon the marauders.

SUPPLY AND USES.

This pine has several names, all of which are based on the fruit it bears. It is called nut pine, piñon pine, piñon, and New Mexican piñon, and is one of the four pines of the far West whose nuts are important as food, the others being the singleleaf piñon, the Parry pine, and the Mexican piñon. The tree under consideration has its range in Colorado, New Mexico, and western Texas. It grows to an elevation of 9,000 feet or more, and the available supply is considerable, though it can scarcely be classed as a timber tree in the ordinary meaning of the term. Its trunk is so short that it seldom makes more than a crosstie or fence post. It usually branches a few feet above the ground, and has the appearance of a large shrub.

The piñon has been tested as tie timber and as such has had a limited commercial use. Some 20 years ago the Rio Grande Western Railroad laid 2,000 piñon ties as an experiment, and the result was believed to be satisfactory. In some other instances where this wood has been similarly used ties occasionally broke under the strain of traffic, the rails cut the wood, and sometimes, with resinous specimens, the ties split when spikes were driven. Complaint has also been made that the wood's holding power upon spikes is poor.

Reports are conflicting also with regard to the value of this wood for fence posts, of which comparatively large numbers are used. Sometimes they have offered satisfactory resistance to decay, and at others have lasted only 3 or 4 years. This difference may be explained by the fact that some of the timber is very pitchy and some is not. The posts for an experimental coyote-proof pasture fence in Cochetopa National Forest, Colo., are of this timber.

In all parts of the tree's range it is cut for fuel. Where the demand is strong large areas have been partly or wholly stripped to supply it. In some parts of Colorado $8 a cord has been paid for it. Few softwoods rank above it in fuel value.

Telephone poles are sometimes cut of piñon, but on account of its poor form its use as poles can never rise to importance.

Charcoal burners in all parts of its range have cut it for fuel for local forges. The wood is pressed into service for various ranch uses, usually because it is the best available in particular localities. Among such uses are parts of wagons and sleds, neckyokes, pickets, corral poles and posts, culverts, sheds, and cabins.

The nuts borne by this tree give it one of its chief values. The Indians and some of the early settlers of the region gathered the nuts for food. This is still done to some extent, and local stores offer them for sale. The tree is a less prolific seeder than is the singleleaf piñon of eastern California and western Nevada. The nuts are not carried by the wind, but fall near the trunk of the parent tree, where they are easily collected by Indians and by birds and rodents. So

few escape that reproduction is scanty in most localities, and that fact will have its influence upon the future supply of this species.

PARRY PIÑON (Pinus quadrifolia).

PHYSICAL PROPERTIES.

Dry weight of wood.—35.4 pounds per cubic foot (Sargent).

Specific gravity.—0.57 (Sargent).

Ash.—0.54 per cent of weight of dry wood (Sargent).

Fuel value.—76 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—6,400 pounds per square inch, or 40 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—565,000 pounds per square inch, or 27 per cent that of longleaf (Sargent).

Character and qualities.—Wood moderately heavy, soft, compact; annual rings very narrow; summerwood thin, not conspicuous; resin passages very numerous, large, conspicuous; medullary rays numerous, obscure; color light brown or yellow, the sapwood much lighter.

Growth.—Height, 15 to 30 feet; diameter, 10 to 16 inches.

SUPPLY AND USES.

The Parry piñon's range is confined to the extreme south of California and to Lower California, but it is more abundant south than north of the international boundary. It is too small a tree to figure largely in lumber production, even if it were plentiful. It is cut for fuel, and a little is employed about ranches for fencing, posts, and for repair of farm implements. The Indians of the region, and occasionally the Americans, make use of the large nuts for food. The seeds are wingless and seldom get themselves planted far from the parent tree. It is not probable that this pine will ever become more important than it is now.

MONTEREY PINE (Pinus radiata).

PHYSICAL PROPERTIES.

Dry weight of wood.—28.5 pounds per cubic foot (Sargent).

Specific gravity.—0.46 (Sargent).

Ash.—0.3 per cent weight of dry wood (Sargent).

Fuel value.—61 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,000 pounds per square inch, or 62 per cent that of longleaf pine (Sargent).

Factor of siffness (modulus of elasicity).—1,415,000 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood light, soft, strong, and rather tough; annual rings very wide; summerwood not broad, resinous, conspicuous; color, light brown, the very thick sapwood nearly white.

Growth.—Height, 70 to 90 feet; diameter, 18 to 30 inches.

SUPPLY AND USES.

The Monterey pine's range is restricted to the California coast, south of San Francisco, and to the islands adjacent. It will grow in pure stands, but it does not live long in arid situations, nor does it thrive in wet soils. It can, however, grow in the shade, and it is not

forced to retreat before other trees. This characteristic will be important if the tree should ever be planted for timber. It grows as rapidly as the loblolly pine of the east, the annual rings sometimes being nearly an inch broad, and trees from 28 to 35 years old are 16 to 18 inches in diameter. It commonly attains a height of from 70 to 90 feet, but the largest trees are taller than this, and sometimes attain a diameter of 6 feet. The tree has been planted for ornament and shelter belts, and a portion of the small quantity of its wood that has been used has been cut from planted trees. It is employed as fuel, a little lumber is occasionally sawed from it, and a small amount finds place as ranch timber near the coast. The tree bears abundance of seeds, but the cones remain closed from 6 to 10 years.

COULTER PINE (Pinus coulteri).

PHYSICAL PROPERTIES.

Weight of dry wood.—25.8 pounds per cubic foot (Sargent).

Specific gravity.—0.37 (Sargent).

Ash.—0.37 per cent of weight of dry wood (Sargent).

Fuel value.—55 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,700 pounds per square inch, or 66 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,622,000 pounds per square inch, or 77 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, moderately strong, very tough; annual rings narrow, summerwood broad, resinous, conspicuous; resin passages few, large; medullary rays numerous, prominent; color, light red, the thick sapwood nearly white.

Growth.—Height, 40 to 70 feet; diameter, 18 to 30 inches.

SUPPLY AND USES.

The Coulter pine is confined to the coast regions of California, between San Francisco Bay and the Mexican line. It never occurs in pure stands, and the available supply is small. The tree bears considerable resemblance to the western yellow pine, but is much inferior in size. Trunks of 10 or 15 feet length are rare, and diameters of from 18 to 30 inches are a fair average. In size of cone this pine surpasses all others, and the cones are further remarkable for the sharp, hooked claws on the ends of the scales. It is not an aggressive tree, and does not push with vigor into vacant spaces, but holds the ground fairly well which it already has. It need not be expected that it will ever exercise much influence upon the lumber supply of the region where it grows. In some localities its short trunk has been sawed into rough lumber for fences, barns, sheds, and irrigation flumes. A larger amount has gone into cordwood, and for that use it is fairly profitable when accessible to market. Its fuel value is a little under that of western yellow pine. It was once burned in pits for charcoal to supply local blacksmith shops, but it is seldom put to that use now. It is known as Coulter pine, nut pine, big cone pine, and large cone pine.

TORREY PINE (Pinus torreyana).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.4 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.35 per cent weight of dry wood (Sargent).

Fuel value.—68 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,600 pounds per square inch, or 66 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—803,000 pounds per square inch, or 38 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood, light, soft, moderately strong, very brittle, compact; bands of small summerwood broad, resinous, conspicuous; resin passages small, few; medullary rays numerous, obscure; color, light red, the sapwood yellow or nearly white.

Growth.—Height, 18 to 30 feet; diameter, 8 to 15 inches.

SUPPLY AND USES.

The range of the Torrey pine is restricted to a small portion of San Diego County, Cal., and to the islands of Santa Cruz and Santa Rosa. The species is rapidly disappearing, the small supply upon the mainland having been drawn upon for fuel and for local use on ranches until little remains. It is sometimes called the Soledad pine—"pine of solitude." Where it grows in the sweep of sea winds its usual height is from 25 to 35 feet, with a diameter from 8 to 14 inches, but in sheltered situations it forms a fairly straight trunk from 40 to 60 feet or more high and is fit for small saw timber. It is so scarce, however, that it is seldom cut.

GRAY PINE (Pinus sabiniana).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.2 pounds per cubic foot (Sargent).

Specific gravity.—0.48 (Sargent).

Ash.—0.4 per cent weight of dry wood (Sargent).

Fuel value.—65 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—830,000 pounds per square inch, or 39 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood light, soft, rather strong, but brittle; annual rings generally wide; the wood of isolated trees is coarse and twisted grained, the wood of closely grown timber is much finer and softer; summerwood broad, very resinous, resin passages few, large, prominent; medullary rays numerous, obscure; not durable in contact with the soil.

Growth.—Height, 50 to 70 feet, but sometimes 100 or more; diameter, 18 to 30 inches, with occasional trees more than 3 feet.

SUPPLY.

This tree is generally called digger pine in the region where it grows, but in literature it is known as gray pine, grayleaf pine, and Sabine's pine. Its range is in the form of an elipse 500 miles long

and 150 wide, a band or rim surrounding the central California Valley. Its northern limit is near Mount Shasta, its southern near the Mojave Desert. The timber does not descend into the valley region of California, but grows as a fringe on the hills and mountains on all sides of it. It actually occupies some 30,000 or 40,000 square miles, but the stand is scattered and the total quantity comparatively small. It is seldom fit for or counted as saw timber. The trunks go to limb and are thick rather than tall. In many instances this is due to the loss of the leader or topmost shoot, through attack of two microscopic fungi, *Peridermium harknessi* and *Dædalia vorax*.

Gray pine appears to be holding its own in most parts of its range. It grows rapidly under circumstances by no means favorable, and for that reason it is worth caring for. It endures drought, sometimes severe enough to kill the chaparral and oaks associated with it. Parched and sterile soils afford it nourishment, but it responds to better conditions, and a few years bring it to size fit for mine props and cordwood, while a period of 85 years has been known to produce timber 90 feet high and 46 inches in diameter. The extreme recorded age of this pine is 175 years. Better fire protection is doing much to encourage its reproduction and growth. Seedlings are more numerous than formerly, and though it is a light-demanding tree, it thrives in tolerably dense stands, which produce a better kind of wood—softer and finer—than open stands and straggling growths. Seeds do not plant themselves far from the parent tree, because they are heavy and have very small wings. This places them at a further disadvantage, for seed eaters, be they bird, beast, or human, can easily find the large, chocolate-colored nuts where they fall. Herds of hogs roaming the pine belts are the greatest enemies of this pine, next after fire. If tree seeds are worth 5 cents a pound, a hog turned loose to forage on wild mast will devour several times his own value in a single season. The portion of its range lying in National Forests, where fire and hogs are held in check, shows promising young growth of seedlings. Where within the habitat of the gray pine the foothill oaks have been cut for fuel, and reproduction has almost ceased, the pine is gaining and in time its importance as a fuel supply will be recognized.

This pine will, it is believed, produce saw timber if given a chance on soils fairly good. In parts of California where it grows on adobe soil the wood is willingly accepted for mine props, both on account of strength and durability.

EARLY USES.

The first settlers in California soon came in contact with gray pine, which grew just above the oaks of the valleys, lower canyons, and foothills. Oak was preferred for fuel where it was convenient,

not because it made a better fire than the pine, but because it was easier to cut. The fibers of gray pine are interlaced and bound together, the wood is split with great difficulty, and chopping is a slow process. For that reason the early woodcutters preferred oak until it became scarce. The pine could be had in poles and logs of greater length and of more shapely form than oak, and was preferred for fencing, corrals, and sheds. As long as placer mining prevailed little timber was needed, but when quartz mines began to be opened, props and frames were in demand. Gray pine at once rose to a place of importance, because in many instances it was more plentiful than any other timber. Tunnels were braced and roofed with it. The wood quickly decays, but commonly that was not a serious drawback, for a mine was often worked out in a few months, or within that space of time the prospector would discover that it was unprofitable and abandon it. Another important use of this wood for mining purposes came with the introduction of the steam engine to take the place of the arrastra, or stone drag, of early days. The engine demanded fuel, and though all kinds went to the furnace, gray pine was often most plentiful, and therefore most important. In many mining districts it was stripped clean for miles. Not infrequently it was carried on the backs of burros, with peculiarly constructed pack saddles, over narrow trails where sleds and wheeled vehicles could not be taken. In two ways the pine was economical for steam engines in remote mines—it was light in weight and made more heat than an equal weight of oak.

Fence posts of this pine were frequently set when other woods were not convenient, but it was poor material. A mass of fungus would appear at the surface of the ground within three or four months after rain had dampened the wood, and in a very short time the post would rot off. Split posts gave no better service than round. An average of cost and term of service for posts of three woods, in the San Joaquin Valley, Cal., gives for redwood 25 cents each, with from 20 to 25 years' service; incense cedar, 20 cents and from 15 to 20 years' service; gray pine, 10 cents and from 1 to 2 years' service.

The wood of this pine was long preferred for ox yokes in the lumber regions of California. Plow beams were once, and still occasionally are, made of it; and it gives satisfaction for wagon bolsters in local shops and factories.

MANUFACTURE AND PRODUCTS.

Efforts up to this time to give gray pine posts preservative treatment to retard decay have not produced satisfactory results. The oleo-resin of this wood does not permit creosote to enter deeply or easily, and more experimenting seems necessary before a cheap and effective process of treatment can be put in practice to make the wood available for fence posts.

It is believed that if gray pine is permitted to grow in good soil and in fairly dense stands it will produce saw timber of considerable value. It has been manufactured, on a small scale, in some parts of the Coast Range, and early settlers on Huer Huero Creek, a tributary of Salinas River, built their cabins of gray-pine lumber. Experience has shown that saw logs should be peeled at once after felling, and ought to be converted into lumber within a month or two. The seasoning should take place in the shade, and heavy weights should be piled on the boards to prevent warping. A fair second-grade lumber will result.

BY-PRODUCTS.

Many chemists in Europe and America have been interested in the resin or turpentine produced by the gray pine. A single manufacturer placed an order for 500 barrels; and several years ago the Alaska Fur Company bought the entire output of a small distilling plant at North Fork, Madera County, Cal. The plant distilled about 20 barrels a year of high-grade turpentine from large roots. The plant burned down about 15 years ago, and manufacturing at that place stopped.

There are two flowing seasons for this tree in the Sierra Nevadas. One opens very early, and closes when the weather grows hot; the other is in full current by the middle of August. The trees are so scattered and of so many sizes that the profitable gathering of turpentine will be difficult. It is said that to procure 500 barrels 50,000 trees must be tapped, and this number of trees can be found only by covering large areas.

The seeds of the gray pine are of local value for food, though not in the same degree as those of the singleleaf pine east of the Sierras. The gray-pine nuts have hard shells and must be broken by force before the kernels can be extracted. The Indians gather them in the fall. Next to the Coulter pine, this tree's cones are the heaviest of all American pines.

WHITE BARK PINE (Pinus albicaulis).

PHYSICAL PROPERTIES.

Weight of dry wood.—26 pounds per cubic foot (Sargent).[1]

Specific gravity.—0.42 (Sargent).

Ash.—0.27 per cent of weight of dry wood (Sargent).

Fuel value.—56 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,150 pounds per square inch, or 51 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—729,000 pounds per square inch, or 34 per cent that of longleaf pine (Sargent).

[1] The weight, specific gravity, ash, fuel value, breaking strength, and factor of stiffness were calculated from a single specimen of the wood which grew on the Frazer River, British Columbia.

Character and qualities.—Wood light, soft, brittle, compact, annual rings very narrow, grain fine, but nearly always twisted; summerwood thin, not conspicuous; resin passages numerous, not large; medullary rays numerous, obscure; color pale brown, sapwood nearly white and very thin.

SUPPLY AND USES.

The white bark pine's range covers parts of Montana, Idaho, Washington, Oregon, Nevada, Arizona, and California. The color of the bark gives the name, but it is also called white stem pine, scrub pine, pitch pine, white bark, creeping pine, and alpine white bark pine. These names are descriptive.

If this tree grew in a region of abundant timber supply it would be considered of no importance, because of its scarcity and its gnarled and unshapely form. It is not of great importance in the region where it is found, though it is sometimes the only tree to be seen on bleak mountains, just below perpetual snow. Occasionally, however, a miner, camper, sheep herder, or traveler makes use of it to supply his urgent wants when no other wood can be had. It is one of the three or four most enduring mountain trees of the United States. It grows at elevations of from 5,000 to 10,000 feet in Idaho and Montana, and in California ranges to 10,000 and 11,000 feet. Growing commonly in pure parklike stands at extreme altitudes, at its lower range it has for associates alpine fir, Engelmann spruce, Lyall larch, limber pine, and lodgepole pine. It survives a temperature sometimes 60° below zero and storms that render most other forms of vegetable life impossible. Its own seedlings frequently perish, not from cold or drought, but because the wind thrashes them against the rocks that surround them and wears them to pieces. Those that survive are apt to take on shapes little resembling trees, but rather like vast, green spiders a hundred feet in circumference that seem sprawling over the rocks. This applies only to the highest and most exposed mountains; for the tree has a wide range, and in some parts of it the timber is of fairly respectable size and form. In the Mono Basin, east of the Sierras in California, fence posts are sometimes cut from the white bark pine; and in other localities a little fencing material is procured, while in every part of its range, along the mountains from British Columbia to Mexico, it makes fuel for those who live in or pass through the region where it grows.

On the Clearwater and Nez Perce National Forests the species is found in merchantable size over rather large areas at altitudes of from 5,000 to 6,800 feet. The trees are about 40 feet high and have a merchantable length of 24 feet. Similar growth is reported in places in Montana.

On high mountains where the snowfall is heavy the limbs of this tree may extend 20 feet or more and lie on the ground like creeping vines. The snow holds them down during half of the year, and they can not rise when the weight is removed. Wild sheep, deer, bears,

and other animals understand the value of the recumbent branches in time of severe weather and creep beneath them for shelter. Travelers, overtaken by storms, have done the same, and it is thus apparent that the uses of this tree are not confined to what may be done with the wood when it is cut.

The slow growth of the white-bark pine, particularly in the most exposed situations, may challenge comparison with the trees of slowest growth anywhere. Trunks 3½ inches in diameter may be 225 years old; one 6 inches through had 426 rings; while one 17 inches in diameter was over 800 years old and less than 6 feet high. By the aid of a magnifying glass John Muir counted 75 rings in a branch one-eighth inch in diameter. Such a branch is so tough and so pliant that it may be tied in a knot like a cord. Muir said that he knew of only two trees which are never uprooted by the wind—the white-bark pine and the mountain juniper, which is associated with it in the Sierra Nevada Mountains.[1] Though the white-bark pine may never be wind thrown, trunks with roots and branches attached are sometimes found at the base of precipices, on the summits, or against the sides of cliffs where they once grew. The breaking away of the rock, by freezing or otherwise, may have thrown them down. Such an accident sometimes furnishes fuel for a mountain traveler's night camp where otherwise he would sleep without fire. Some of these trunks and roots, when the branches have been broken off, are of such strange form that a rather close examination may be necessary to determine which end grew upward.

It need scarcely be said that man will never do much to help or hinder the growth or existence of this tree. Even forest fires seldom touch the white-bark pine. It grows among rocky masses where fire finds so little fuel that it can not go. The tree plants its seeds within a few inches of where they ripen and fall. They come wingless from the cones. It seems that nature's handicap begins even before the seed makes its escape from the inclosing scales, for the short wing that might be supposed to aid the seed in finding a place to be planted grows fast to the scale and holds the seed until it can free itself by tearing its wing off, when it falls to the inhospitable rocks or sterile soil beneath. Under such adverse circumstances it is too much to expect the white-bark pine to extend its range or to increase its importance. The wonder is that it is able to hold its own.

In its best growth the wood of white-bark pine much resembles that of white pine. Where it grows in size to give a clear length of from 20 to 30 feet, it should serve fairly well for rough construction material in the form of building logs, mine props and stulls, bridge timbers, fence posts, and for fuel. The seeds are used by Indians as food.

[1] Mountains of California, by John Muir.

LIMBER PINE (Pinus flexilis).

PHYSICAL PROPERTIES.

Weight of dry wood.—27.2 pounds per cubic foot (Sargent).

Specific gravity.—0.44 (Sargent).

Ash.—0.28 per cent of weight of dry wood (Sargent).

Fuel value.—60 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,700 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—937,000 pounds per square inch, or 44 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood light, soft, narrow-ringed, compact; summerwood narrow, not conspicuous; resin passages numerous, large; medullary rays numerous, conspicuous; color light, clear yellow, changing to reddish on exposure, the sapwood nearly white.

Growth.—Height, 30 to 50 feet; diameter, 12 to 36 inches.

SUPPLY.

The limber pine is known also as white pine, bull pine, Rocky Mountain white pine, and limber-twig pine. Its drooping limbs are long, slender, and flexible, hence its name. It ranges from Canada southward along the Rocky Mountains to New Mexico and extends westward into Arizona and California. In the Sierra Nevadas the upper limit of its range is 12,000 feet. In the Rockies, at the lowest range of this tree's growth and from 4,000 to 6,000 feet elevation, it forms open, scattered stands of round-topped, stunted trees of no commercial value, usually in company with Rocky Mountain red cedar or western yellow pine. At timber line—from 8,500 to 10,000 feet—it assumes a similar or even more stunted form, associating with Lyall larch or other alpine species. At intermediate elevations it occasionally produces merchantable timber in company with Douglas fir, and possibly also with white-bark pine, lodgepole pine, Englemann spruce, and alpine fir.

It is, or was once, the most important timber tree of central Nevada, but in many districts it has been cut clean to supply mine timbers, rough lumber, fuel, fencing, and charcoal. It forms a small proportion of the merchantable stand in the Gallatin and the Lewis and Clark National Forests, in company with Douglas fir, lodgepole pine, and white-bark pine. It is a tree of slow growth. Its seeds are practically wingless, and reproduction is restricted to the immediate vicinity of the parent.

It is commonly a low, thick-trunked, much-branched tree, usually between 25 and 50 feet high, with a trunk anywhere from 5 inches to 3 feet in diameter. In its usual habitat the tree is so stunted and the trunk so short as to yield no merchantable logs. In better locations, however, it is possible to cut 10-foot or even longer logs. When mixed with other species in sheltered canyons it is a tall, straight tree, in shape somewhat similar to lodgepole pine. As compared with

white bark pine, when grown in the same situations, the limber pine has the longer, straighter trunk of the two.

USES.

It is seldom that the quality of the wood of this pine is sufficiently good for saw timber, and even then a good proportion will be very knotty. Frequently large trees show decay at the heart. When logs fairly clear and sound can be procured the lumber is suitable for window frames and interior finish. In the Rocky Mountains this wood is among the best native species for flooring, when sufficiently clear for that use; but very little of the grades demanded for flooring or finish ever reaches market, and what does go to market is listed simply as pine, and the purchaser seldom knows the exact species he is using.

When green the wood is extremely heavy, and if left in water any length of time will sink. After being seasoned, however, it becomes extremely light. At a sawmill which formerly operated on Dupuyer Creek, on the Lewis and Clark National Forest, it was found that limber pine could be manufactured into a good grade of lumber and shingles. The stem of the tree was generally free from defects and knots and could be used for the better grades of finishing lumber. This limber pine had grown mixed with a heavy stand of Douglas fir in a sheltered canyon, and the trees had grown tall and straight. It is seldom, of course, that the quality of the wood can be found as good as that on Dupuyer Creek. In its most common form of growth limber pine is useful only for fence posts and for fuel. The posts are nearly always very knotty and are often of undesirable shape. The wood holds staples well for wire fence, and is durable in contact with the ground, though it is not considered as long lasting as bristle-cone pine when set as posts.

A very unique method of securing a preservative treatment of limber and white-bark pine timber for fence posts is practiced by ranchers in the vicinity of the Madison National Forest, in Montana. A sapling growth the size of the posts desired is selected, and in the spring as soon as the sap runs freely so that the bark will slip, the rancher peels the bark from the standing tree for the length to be used. The tree immediately exudes a sufficient quantity of resin to cover the wound and dies. Six or eight months later the rancher cuts the tree, now thoroughly seasoned, smears the cut ends with tar, and has a post impervious to water and immune to insects or fungus. Posts so treated are said to last many years. One lot was examined which had been set for 20 years, and the posts seemed as sound as ever.

Railroads within reach of this pine buy ties made of sound, fire-killed timber. Miners employ the wood for props, posts, and other timbers, both above and below ground. It is used in mountain roads

and trails for bridges and corduroy. It makes good charcoal. Limber pine has proven the most resistant of any species to sulphurous fumes from copper smelters on the Deerlodge National Forest. It has continued to make thrifty growth where all other species have died from the fumes.

CALIFORNIA SWAMP PINE (Pinus muricata).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.8 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—66 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—14,000 pounds per square inch, or 87 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,652,000 pounds per square inch, or 78 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood, very strong and hard, compact; summerwood broad, resinous, resin passages few, not prominent; medullary rays numerous, thin; color, light-brown, the thick sapwood nearly white.

Growth.—Height, 45 to 90 feet; diameter, 12 to 24 inches.

SUPPLY AND USES.

California swamp pine is not abundant and its uses are few, yet the tree has characteristics which give it local importance. It occurs near the California coast, from 100 miles north of San Francisco to 200 miles south. In the southern part of its range it is sometimes cut for fuel and for small farm timbers, and in the north it is occasionally employed for skids, rough bridges, and scaffolds in lumber operations. It grows in the vicinity of redwood forests, and in cutting that timber some of the pine is made use of. The seeds blow into the openings where the redwood is cut, and in some localities it is taking possession of the ground. It occupies such soils as it finds vacant, and will grow in cold clay, in peat bogs, on barren sand or gravel, and on wind-swept ridges exposed to ocean fogs. It thrives in full sunlight, or it will grow in shade. Its ability to grow where few other trees can maintain themselves promises some future usefulness, though it is not probable that it can ever be of much importance. The wood is very strong and hard. The tree is known by several names, among them dwarf pine, pricklecone pine, bishop pine, and obispo pine ("bishop" being the English equivalent of the Spanish word "obispo").

KNOBCONE PINE (Pinus attenuata).

PHYSICAL PROPERTIES.

Weight of dry wood.—21.8 pounds per cubic foot (Sargent).

Specific gravity.—0.35 (Sargent).

Ash.—0.33 per cent of weight of dry wood (Sargent).

Fuel value.—47 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—5,730 pounds per square inch, or 36 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—616,000 pounds per square inch, or 29 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, brittle; annual rings narrow, due to slow growth; summerwood narrow, not conspicuous; resin passages numerous, large, prominent; medullary rays numerous, thin; color light brown, the thick sapwood nearly white, or slightly tinged with red.

Growth.—Height, 25 to 40 feet; diameter, 8 to 12 inches, though much larger in favorable situations.

SUPPLY AND USES.

Knobcone pine is not a valuable timber tree. It sometimes is cut for fuel and has a few minor uses about ranches and mines, but it is too small and too scarce to become important. It grows in dry mountain regions in Oregon and California, and in exceptionally favorable situations yields small saw timber or good-sized mine props. Like the jack pine of the Lake States, it is short lived, even when no accident overtakes it, but it usually falls a victim to fire. It prepares for an early death by producing cones when from 5 to 8 feet high. Miners once called the tree hickory pine, not because the wood was tough like hickory, but because it was white. A difference of opinion exists as to its toughness, some claiming uses for it on account of that property, while others say the wood is brittle. The latter quality is indicated by the tests which have been made. The cones are so persistent that not infrequently the tree is unable to crowd them off, and they become embedded in the wood. The cones seldom open to release the seed, and a tree may retain the accumulated crops of nearly its whole life, which may amount to 3 or 4 pounds of seed. Then a fire kills the tree, the cones open, and the wind scatters the small black winged seeds upon the bared mineral soil. Seedlings must have light, however, or they will not last long, and this characteristic has given the tree the names "sun-loving pine" and "sunny slope pine." Although the fuel value of the wood is very low, more is used for fuel than for any other purpose.

BRISTLECONE PINE (Pinus aristata).

PHYSICAL PROPERTIES.

Weight of dry wood.—34.7 pounds per cubic foot (Sargent).

Specific gravity.—0.56 (Sargent).

Ash.—0.3 per cent of weight of dry wood (Sargent).

Fuel value.—75 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—9,100 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,032,000 pounds per square inch, or 49 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood moderately light, soft, not strong, very narrow ringed, compact; grain fine and usually twisted; summerwood thin, dark-

colored, conspicuous, resinous; resin passages few, not prominent; medullary rays numerous, obscure; color reddish, the thin sapwood nearly white.

Growth.—Height rarely exceeding 40 feet or diameter more than 3 feet, usually much smaller.

SUPPLY AND USES.

The bristlecone pine, so named because of the sharp bristles on the ends of the cone scales, is a high-mountain tree, running up to the timber line at an altitude of 12,000 feet, and seldom occurring below 6,000 or 7,000 feet. It ekes out its existence in many regions on dry, stony ridges, very cold and stormy in winter and subject to protracted drought during the growing season. Under such conditions a large and symmetrical tree is impossible, and the bristlecone pine's trunk is short, excessively knotty, and tapers rapidly. It reaches its best development among the Rocky Mountains, but extends its range westward to the mountains of California, and is found in Utah, Nevada, and northern Arizona. It grows slowly and reaches an age of 200 years or more.

The great altitude at which it grows and the remoteness of the districts where it abounds would exclude it from many of the common uses. In addition to that disadvantage, it is not desirable in either form or quality. Yet in spite of these drawbacks it has been and still is important in certain localities. Many valuable mines in central Nevada were developed largely through the use of this unshapely tree. In some sections it was cut so closely that scarcely a seed tree was left. It was made to serve as mine props, stulls, lagging, windlass frames, cabins, fuel, and other necessary accessories to mining. It was sometimes the best charcoal wood obtainable, and the product of the pits was carried long distances on pack animals to supply blacksmiths in mining camps.

It is rarely sawed into lumber, but is occasionally employed as fence posts, the resin in the wood causing it to give fairly long service. Its use as railroad ties has been reported, but it is not listed as tie material by any of the leading railroads. It finds place in the construction of stock corrals, sheds, fences, and sometimes barns and cabins. The grain of the wood is so involved and twisted, and so many knots abound, that no split commodities, such as shingles, shakes, or pickets, can be made from it.

There is no likelihood that the bristlecone pine will ever rise to an important place in the country's lumber supply, but it is perhaps the most valuable crop that the sterile and rocky peaks and ridges will produce. It crowds out no tree that is more valuable, and it is able to maintain its existence. Its small seeds have ample wing area, and the wind carries them to a distance of 600 feet or more from the parent tree. They take root and grow in rocky soil where no humus is visible.

FOXTAIL PINE (Pinus balfouriana).

PHYSICAL PROPERTIES.

Weight of dry wood.—33.9 pounds per cubic foot (Sargent).

Specific gravity.—0.54 (Sargent).

Ash.—0.4 per cent of weight of dry wood (Sargent).

Fuel value.—73 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—5,900 pounds per square inch, or 37 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—846,000 pounds per square inch, or 40 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood moderately light, soft, weak, brittle; annual rings very narrow, compact; summerwood very narrow, dark-colored; resin passages few, not conspicuous; medullary rays numerous, obscure; wood satiny and susceptible of a good polish.

Growth.—Height, 30 to 50 feet; diameter, 10 to 16 inches.

SUPPLY AND USES.

This tree is occasionally called spruce pine. It is confined to California and to a few of the high mountain regions. It is too scarce to be of much importance as a source of lumber, yet it is sometimes cut where it is associated with other species near the lower limits of its range. Trees are small and knotty, but when a clear stick is found the wood is compact and susceptible of a good polish. Its growth is slow. Where the tree is at its best it attains a diameter of about 18 inches in 300 years and a height of 60 feet or less. In the higher parts of its range it is too small, ragged, and dispersed to have value other than as fuel, and not much for that, since few people live in those regions. It grows at an elevation of 13,000 feet near Farewell Gap, in the Sierras, and few species, if any, in this country equal it for altitude. Within its range it is frequently the upper fringe of the timber line, its nearest neighbors being the white-bark pine and western juniper. This pine's seeds, unlike those of the white-bark pine, escape with their wing from the cone and are widely scattered by wind, thus assisting the tree to maintain its position in regions which otherwise would have little or no timber of any kind. Sheep herders, miners, tourists, and others who spend the summer among California's highest mountains are often indebted to the foxtail pine for their camp fuel. Near the upper limit of its range the tree frequently dies at the top—which is often not much above a man's height—and the dry wood, which is barked by the wind and bleached and whitened by sun and age until it resembles bone more than wood, is gathered by breaking off the dry branches.

○